THE DEVELOPMENT OF AN INVESTMENT PLANNING TOOL FOR THE MEAT PACKING, PROCESSING AND DISTRIBUTION INDUSTRY

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The Development of an Investment Planning Tool for the Meat Packing, Processing and Distribution Industry

by

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PREFACE

This report summarizes the findings of a study entitled "Analysis of the Efficient Location of the Meat Packing, Processing and Distribution Industry" by Deloitte, Haskins and Sells Associates. It was funded by the Government of Canada's Food Processing, Distribution and Retailing (PDR) Contract Research Program. A copy of the full report (with the same title as this report) may be obtained through the Canada Institute for Scientific and Technical Information, National Research Council, Montreal Road, Ottawa K1A 0S2, or on inter-library loan from Agriculture Canada Library, Sir John Carling Building, Ottawa K1A 0C5.

This report was prepared by the contractor and is distributed as a working paper for discussion and comment. The findings and views expressed are those of the author and do not necessarily reflect the position of Agriculture Canada.

Any questions or comments on this study may be directed to Donald A. West, Food Markets Analysis Division, Marketing and Economics Branch, Agriculture Canada, Ottawa K1A 0C5 (613 995-5880).

The model is being maintained by Agriculture Canada.

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EXECUTIVE SUMMARY

In September 1982 Deloitte Haskins + Sells Associates was commissioned to develop an investment planning tool for the red meat packing, processing and distribution sector. This report concludes the project by describing the project research and development activity, the planning tool itself, and its use in analysis of several anticipated developments which could have important implications for industry participants.

Meat packing and processing is one of Canada's most important manufacturing industries in terms of both sales and employment. Unlike many other manufacturing industries it is almost entirely Canadian owned. As well, economic activity is less concentrated than in some other manufacturing sectors. The basic activity of the meat packing industry is to transform livestock into wholesale products (carcass beef, pork primals and processed pork) which are further transformed and ultimately delivered to consumers through distribution, retailing and food service functions.

Many aspects of these functions are unique to Canada. The geographic distribution of human population (and the demand for meats) is quite different than the geographic distribution of livestock. Hence, the assembly and distribution functions take on an added importance. This is particularly true in the beef sector where Eastern Canada represents 70% of the population but only 40% of the cattle marketings in Canada.

Several events over the last decade have added to the complexity of

these functions. Transportation costs have risen dramatically. The rail tariff for carass beef moving from Calgary to Montreal almost tripled between 1975 and 1983. There have also been significant changes in industry throughput. Cattle slaughter increased more than 25% between 1973 and 1976, was back to 1973 levels by 1979, and has stabilized somewhat since then. Hog slaughter has increased dramatically since 1975. Although some of the increase can be attributed to normal cycles in the industry there is no doubt that there has been a fundamental increase in hog production in Canada. Moreover this increase has been unevenly distributed on a regional basis. Hog marketings in Western Canada have declined, creating excess slaughter capacity in that region, while substantially increased marketings in Quebec have led to a major increase in slaughter capacity in that province.

Even as adjustments are being made to these developments, the industry must prepare to deal with several imminent developments which will affect the industry. Legislation has just been passed implemeting major revisions to the transportation policy for grains produced in the Prairie region. The packing industry must anticipate and take action to effectively deal with changes in the location and level of livestock production which will occur as the effects of changes in grain transportation policy work through the grain and livestock sectors. Provincial programmes have, and will continue to have, an important influence on the regional distribution of livestock marketings. The province of Quebec has been very successful in encouraging the development of hog production and is embarked on what appears to be an equally ambitious attempt to increase cattle feeding in that province.

Provincial stabilization plans for hogs in B.C. and the Maritime provinces, and for cattle in Manitoba and Saskatchewan, have also had significant impacts on the regional distribution of livestock production.

Similarly, technological changes are taking place in the industry, some of which can ameliorate the effects of higher transportation costs. Beef 'boxing', for example is a process in which carcass beef is broken into primal and sub-primal cuts, partially deboned, trimmed, sealed in oxygen impermeable plastic bags, and packed in boxes. The boxed product weighs about 20% less than the carcass and can be stored much longer with less shrinkage. This innovation has been widely adopted in the United States where approximately 70% of all beef is now delivered to retail stores in boxes. And yet it has been adopted much more slowly in Canada where the benefits of reduced distribution costs are probably even more attractive than in the U.S. Developments which are less certain but which nevertheless concern decision makers in the industry are possible changes in foreign trade policy either in Canada or in other countries, and the impact of exchange rate fluctuations on the industry's ability to compete for livestock supply and product markets both domestically and abroad.

The investment planning tool developed here is an attempt to provide decision makers within the industry with a means of analyzing the implications of these developments for: plant location, plant capacity and utilization, the functions to be performed at plants, and distribution/marketing strategies for products. At the same time it can be used by governments to evaluate the impact of public policy on the

industry and provide a means of determining appropriate policy measures to achieve public objectives in the industry.

The planning tool uses an optimization technique (linear programming) which calculates a least cost combination of activities for assembly of live animals, slaughter, fabrication, processing, and distribution of meat products to consumers. Development involved several auxillary activities: a survey of packers, processors, and distributors to determine costs of performing various functions and the assembly and distribution activities of specific plants; development of financial models of cattle and hog slaughter plants; direct contact with co-operating firms to resolve specific problems encountered in the development process; and the assembly of published and unpublished data and analysis. Associate consultants with extensive industry experience and cooperating firms provided valuable assistance in many of these tasks.

Separate analytical frameworks were developed for the cattle/beef and hog/pork sectors. Both are based on a division of the country into sixteen regions. The beef problem deals with two primary products (fed and non-fed beef), three intermediate products (carcass, boxed, and boneless beef), two final products (beef cuts and ground beef), and the inter-regional transportation of any of these products. The pork problem deals with one primary product (live hogs), two intermediate products (carcasses and primal cuts), two final products (fresh pork cuts and processed pork products), and the inter-regional transportation of any of these products.

The performance of the analytical tools was tested by comparing

simulations of the industry in 1981 with actual experience in 1981. Once satisfactory performance had been achieved several analyses were undertaken, viz:

- An analysis of the impact on the industry of projected changes in livestock production, international trade, and demand for meats in 1986. The analysis is based on production and trade projections prepared by Agriculture Canada and population estimates prepared by Statistics Canada.

- An analysis of the impact on the industry of changes in grain transportation policy (Crow Rate). The analysis is based on changes in regional distribution of livestock production estimated by David Harvey in a working paper published by Agriculture Canada.

- An analysis of the impact of increased boxed beef penetration in the retail store market.

- An analysis of the effect of economies of scale in slaughtering on the size and location of slaughter facilities in Canada. The analysis is based on evidence of economies of scale developed from the financial models prepared as a part of this project.

- An analysis of the effect of a decision to discontinue operation of a Charlottetown, P.E.I. cattle and hog slaughter plant.

- An analysis of the effect of increased slaughter capacity (construction of new plant) in two regions. Specifically, a cattle slaughter facility in the East Quebec region and a hog slaughter facility in Nova Scotia.

THE BASE 1986 EXPERIMENT

The major features of industry circumstances, projected for 1986 are increased exports, lower imports, slightly lower cattle marketings, and hog marketings about 6% higher than in 1981. With population changes, per capita consumption of pork is expected to increase slightly whereas beef consumption is expected to decrease slightly. In this scenario the analysis indicates that the flow of carcass and other beef products from Alberta to Quebec would increase, replacing beef from imported cattle. Aggressive encouragement of feedlot sectors in Quebec and in B.C. will create pressure for additional slaughter capacity in B.C. but not in Quebec. Reduced imports of live cattle into Eastern Canada will free capacity for slaughter of increased marketings in Quebec. In the pork sector anticipated increases in hog marketings in B.C. and the Maritime provinces would result in live hog movement to excess slaughter capacity in Alberta and Quebec respectively. As a result pressure may develop for additional slaughter capacity in B.C. and the Maritimes. The expected overall increase in hog marketings will improve capacity utilization in all regions.

A CROW RATE IMPACT EXPERIMENT

The expected changes in industry circumstances five years subsequent to revision of the Crow Rate are an increase of 1.8% in cattle marketings and 4.9% in hog marketings in Western Canada with no change in Eastern Canada. This experiment is essentially an analysis of the impact of a change in the regional distribution of livestock marketings on the meat packing and distribution sectors. A change in freight rates for prairie grains is merely a force which is expected to cause a shift in the location of livestock production. For this reason all other factors

affecting the solution (such as population, per capita consumption, transportation rates, and so on) are held constant. The anticipated impact on the livestock sector of a 'pay the railroads' policy is modest. The analysis indicates that slaughter capacity utilization for both cattle and hogs would increase marginally in Western Canada. The West would, in turn, capture a larger share of the Eastern beef market at the expense of livestock imports from the United States. In the pork sector, Eastern Canada would supply most of the anticipated increase in export demand for both live hogs and pork products.

THE MORE BOXED BEEF EXPERIMENT

Increased boxed beef penetration in the retail market would, according to this analysis, have widespread implications for the beef sector. The export of live cattle, for instance, could be expected to shift from the West to Ontario. No Ontario cattle would be slaughtered in Quebec allowing a rationalization of slaughter capacity in Quebec and the Atlantic provinces. Boxing activity would increase but would not change location, remaining in the Prairie provinces and Ontario. Movement of boxed beef would increase dramatically replacing movements of carcass beef and even live cattle. The net effect is an aggregate saving of 4.8 million dollars per year in assembly and distribution costs.

THE ECONOMIES OF SCALE EXPERIMENT

The analysis of economies of scale indicates that they have an important influence on any assessment of plant size and location. This is particularly true in the pork sector where economies of scale are more pronounced. If economies of scale are not reflected in slaughter costs there is a tendency to slaughter animals in the region in which they are

marketed no matter how few are marketed. In reality there is always a tradeoff between increased cost of assembly and lower cost of slaughter at higher throughput levels. The absence of hog slaughter capacity in Northern and Eastern Ontario may appear irrational, but consideration of economies of scale indicates that no capacity in these regions is consistent with minimum cost assembly, slaughter, and distribution.

THE PLANT CLOSING EXPERIMENT

Reduced beef slaughter capacity in P.E.I. has a chain effect which has implications for a number of regions. Cattle marketed in P.E.I. are slaughtered in N.B. which displaces Quebec marketings. The Quebec cattle remain in Quebec for slaughter but they displace Ontario cattle . Thus the ultimate effect of the P.E.I. plant closing could well be increased capacity utilization in Central Ontario. The effect of reduced hog slaughter is much more straightforward. Live hogs would move to Quebec for slaughter and pork products move from Quebec to satisfy demand in P.E.I.

THE NEW PLANT EXPERIMENT

Increased beef slaughter capacity in the East Quebec region would have significant repercussions in neighbouring regions. Capacity utilization in New Brunswick would drop sharply from 100 to 70%. Capacity utilization would also decline in Central Ontario, from 68 to 63%. In contrast a marginal increase in hog slaughter capacity in Nova Scotia has far more desirable consequences without any harmful side effects. Capacity utilization in the West Quebec region drops only marginally, from 88 to 87% and in New Brunswick from 100 to 92%. Shadow prices on capacity are drastically reduced throughout the region. Nevertheless,

the size selection for a plant in this region is important since one new small scale plant considered in the analysis in Nova Scotia would result in excess capacity in that province. This suggests a need for development of efficient small scale plants.

In conclusion, we are pleased with the planning tool's ability to reflect the structure of the red meat processing sector and the dynamic nature of livestock assembly, slaughter, processing and distribution. The sensitivity of livestock and meat exports is a case in point. Moving a region from an import basis to an export basis has obvious implications for producers, processors and policy makers alike. The analysis of alternative industry scenarios conducted here amply demonstrates the tool's capability for providing the industry and government decision makers with a more comprehensive and yet efficient method of examining the implications of factors that may affect the current balance of processing and distribution activities within the industry.

Moreover, the tool can provide individual packers with considerable insight into the operations of the meat processing sector under varying industry circumstances. It provides a means of identifying emerging opportunities for new or expanded processing capacity, areas where packers can most effectively compete for livestock supplies and for product markets, and a means to determine the appropriate product mix within plants.

Similarly, the planning tool has considerable potential for use in

assessing international trade policy development, domestic livestock product support policies, and most significantly, regional development policy and planning. In this latter area it has the ability to measure the potential impact of changing production or processing capacity in one region on trade flows and processing activity in other regions.

The tool is relatively simple to use and yet comprehensive in its ability to assess the impact of shocks to the system. Nonetheless interpretation of results should be developed in an environment that understands the basic principles of its operation, its limitations, and a basic knowledge of the industry. Used in this environment it can be an important and practical tool for promoting good decision making.

CHAPTER I: THE ECONOMIC PROBLEM

The meat packing and processing industry is a key sector in the Canadian economy. In 1980 it was the fourth largest Canadian manufacturing industry in terms of value of shipments ($6.9 billion). It was also among the top five manufacturing industries in terms of supply purchases ($5.7 billion) labour employed (25 thousand employees) and valued added ($1.2 billion).

In the prairie region it is the most important manufacturing industry by all of these measures. In Alberta it is second only to petroleum refining in terms of value of shipments.

The meat packing and processing industry is very much Canadian owned and operated with only 5% of 1980 sales under the control of foreign enterprises. By contrast in the manufacturing sector as a whole 46% of total 1980 sales were under the control of foreign enterprises.

It is also an industry in which enterprise concentration is lower than in many other sectors. In 1980 the four largest enterprises controlled 43.3% of sales in the slaughter and meat processing industry; this compares to 61.7% of sales in petroleum refining, 77.9% of sales of iron and steel mills, and 93.7% of sales in motor vehicle manufacturing. Moreover, it is apparent that concentration in the industry is declining. The four largest enterprises fell from 62% of industry sales in 1965 to 43% in 1980. Financially, the industry is characterized by low after-tax profits on total income (1.2% in 1980) but nevertheless

realizes a reasonable return on equity (13.4% in 1980).

The industry is under considerable economic pressure from several quarters. Rapidly escalating transportation costs have been an important factor in the beef sector, primarily because a substantial movement of beef from the prairie provinces to central Canada is required to balance production and consumption. The rail tariff for beef moved from Calgary to Montreal has tripled since 1970, increasing from $3/cwt to $9/cwt for carlots of 60,000 pounds. As the transportation component of total marketing costs becomes increasingly important, then so does the need to seek economies in moving live animals to point of slaughter, and meats from packing houses to point of sale. Technological developments such as the introduction of 'boxing' by beef packers and by some major retail chains appear to present opportunities to lessen the impact of transportation cost increases. Nevertheless the opportunities have not been exploited to the same extent in Canada as they have in the United States. In 1981 boxed beef penetration in the retail sector in Canada was estimated at 40% while in the United States it was approaching 70%. Efforts to cope with the changing transportation cost and processing technology environments will have a significant impact on the location, size and type of slaughtering and meat processing facilities. A number of significant changes are already underway in terms of plant closures, changes in the operations carried out at plants, and in the construction of new plants.

In the pork sector, there has been substantial change in the regional distribution of livestock production and, in turn, in the location of slaughter capacity. Figure I.1 shows changes in the level of hog

slaughter in Canada over the last 10 years and the distribution of slaughter between Eastern and Western Canada. Eastern Canada's share of national hog kill increased dramatically from 55% in 1972 to 73% in 1982. In addition, Canadian hog production in the last four years represents an increase of almost 40% over the highest production in any previous period. The increase has been most pronounced in the province of Quebec and has resulted in the construction of several modern, large scale and efficient slaughter plants in that province. By contrast, hog production (and slaughter) in Western Canada has been ten or more percent below the level of slaughter prevailing at the beginning of the 1970's. As a consequence some contraction of hog slaughter capacity in that region has been necessary.

The beef sector experienced a 25% increase in the numbers of animals slaughtered from 1973 to 1977, a 25% decline in numbers slaughtered from 1977 to 1979, and over the last two years has been operating at a level about 10% below the peak level in 1979 (see Figure I.2). This series of events has had some profound effects on the structure of the industry both in terms of plant closures and reorganization of existing facilities.

The importance of livestock as a generator of employment and investment in both the farm and manufacturing sectors is substantial and is of obvious interest to federal and provincial governments. The accomplishments of Quebec in the pork sector have already been noted. An equally ambitious program for cattle feeding in this province seems to be underway. British Columbia is another province in which hog and cattle feeding have been successfully encouraged through provincial

FIGURE 1.1.: FEDERALLY INSPECTED HOG SLAUGHTER 1972 - 1983

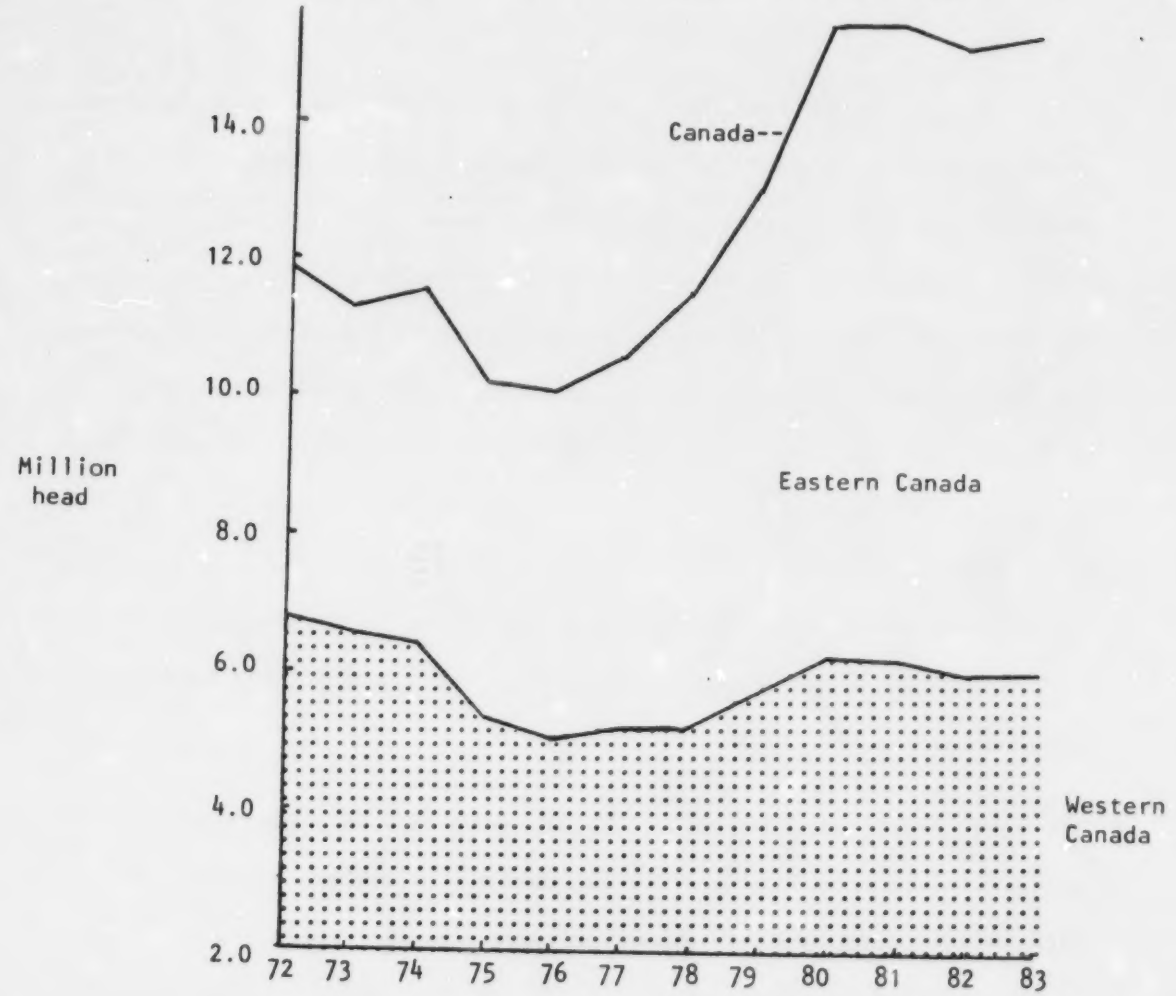
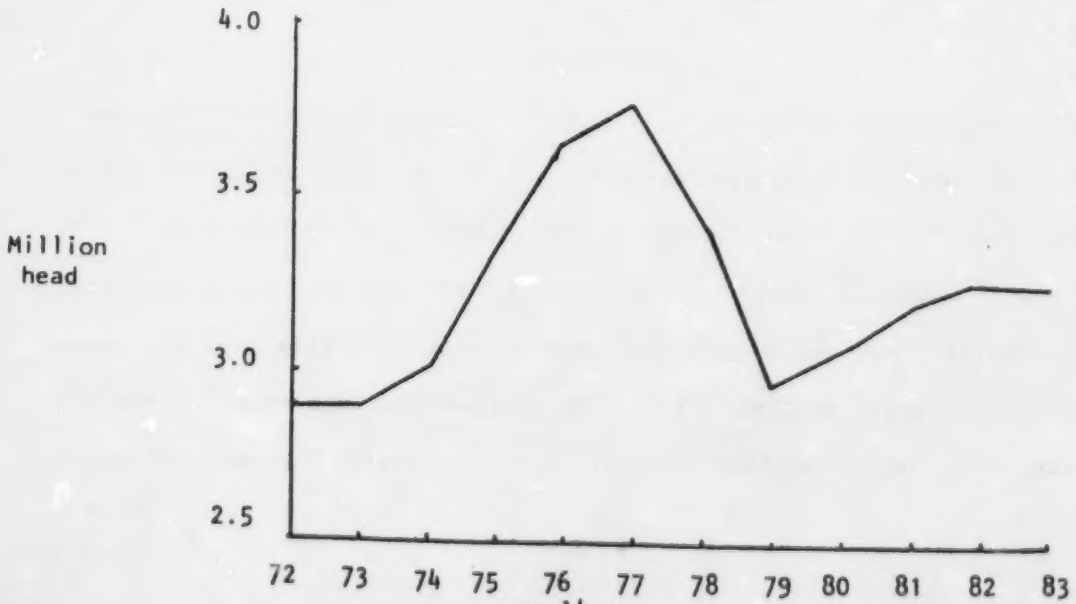


FIGURE 1.2.: FEDERALLY INSPECTED CATTLE SLAUGHTER, 1972 to 1983



programs. The implementation of provincially backed stabilization plans in the Maritime provinces has undoubtedly had an influence on hog production in that region. Similar stabilization plans for beef in Saskatchewan and Manitoba are designed to encourage cattle feeding as opposed to the sale of calves and yearling feeder cattle. Virtually all of these programs place unusual demands on slaughter capacity and the assembly and distribution systems.

Other forces, although not as dramatically evident, are also being felt. There has been a substantial shift of population from Eastern to Western Canada. In 1970 the four Western provinces accounted for 27% of the Canadian population but are expected to account for 30% by 1986. Although such changes are small on an annual basis they are significant when the planning horizon is ten or twenty years and therefore deserve attention when decisions are made on investment in the meat packing industry.

Although little concrete evidence exists, there is a feeling in the industry that there have been significant changes in demand for red meats and that, all things being equal, consumers have reduced meat consumption.

These forces have already resulted in a number of adjustments in the industry. There have been numerous plant closures in Western Canada since 1978: Swift in Winnipeg; plants in Regina and Prince Albert; Burns, Gainers and Canada Packers in Edmonton; and Gainers in Lethbridge. In Ontario Prime Packers and Windsor Packers have closed due to bankruptcy, Canada Packers has announced the closure of their Toronto plant and a shift of operations to purchased and renovated

plants in Burlington and Kitchener. Canada Packers has also announced the closure of their plant in Prince Edward Island.

It is not clear that sufficient adjustment to current conditions has taken place. Yet there are major uncertainties about future developments in several areas affecting the slaughter and packing industry. The revisions to the Crows Nest statutory rates for shipment of prairie grains will have an effect on the distribution of livestock production. Uncertainty as to the nature and extent of impacts on livestock production can create a lack of direction in the industry and impede rationalization.

A second major source of uncertainty facing the industry is the competitive position of the Canadian industry in relation to its U.S. counterpart. Major structural changes in the U.S. industry have resulted in very large scale, low cost slaughtering facilities which are perceived as a potential threat to the Canadian industry. The concern over this threat increases as the differential between wages for plant workers in the two countries widens. The extent to which this threat can be consumated depends in part on the exchange rate between the Canadian and U.S. dollar. If the Canadian dollar moves towards par with the U.S. dollar, American competitiveness in the Canadian market will increase. This could affect trade flows for both primary products (livestock) and finished products (meats) and have a profound effect on the meat packing industry in Canada.

Finally, there are numerous other potential developments which could have an impact on the meat packing industry in Canada and therefore add to the uncertainty surrounding investment and planning decisions. Removing restrictions on the importation of live hogs from the U.S., modification of the U.S. meat import law or its enforcement, and disruptions to normal world trade patterns caused by events such as the outbreak of foot and mouth disease in Denmark are examples of events over which the industry has little control but which can have significant impacts.

The meat packing and processing sector is a key industry in Canada and is currently faced with considerable uncertainty as to its future direction as a result of economic and political factors which may have a long-term impact on its overall economic viability, as well as the viability of individual meat packing and processing plants within specific regions. Hence, numerous questions and issues arise pertaining to the structure and overall efficiency of the industry and the impact of anticipated changes on regional economic activity , on inter-regional trade patterns, and on optimal resource allocation within the industry.

The purpose of the project described in this document was the development of an investment planning tool which would assist the industry and individual firms within the industry to effectively address these questions and issues, and to help governments formulate appropriate and effective policies for the accomplishment of public objectives in the industry.

As such the objectives of the study are consonant with the general objectives of the Processing, Distribution and Retailing fund, viz: the development of economic or technical information to be used by industry or government in effecting improvements in the functioning of various facets of the PDR sectors and the development of more efficient processing, storage or distribution methods.

CHAPTER II: THE RESEARCH PROBLEM

The environment of change and uncertainty which prevails in the Canadian meat packing industry presents numerous problems, and opportunities, for individual firms and for governments interested in maintaining a healthy industry.

Multi-plant firms must deal with questions relating to plant location whether they are contemplating the construction of a new plant or discontinuing operations at an existing plant. All firms are faced with important decisions when livestock availability changes creating the need to increase or reduce plant throughput. At the extreme, these decisions lead to plant construction or closings, but more often involve decisions about changes in working hours and staffing levels. Closely related to these decisions are questions pertaining to the firm's livestock acquisition activities, the kinds of output which the plant produces, and the markets in which the firm can most successfully compete in selling its products. The information required to make these decisions is extensive and not always easy to evaluate. In terms of livestock acquisition, present and projected livestock marketings in the geographic area surrounding the plant must be clearly defined and the competition from other plants for available supplies evaluated. The extent of the area in which a plant can compete effectively for livestock supplies will depend on livestock transportation rates and the plant's location in relation to markets for finished product. The nature of the plant's operations can vary considerably and will depend

on markets in which the plant can compete effectively. Many plants for both hogs and cattle kill and ship only. A wide variety of other functions can be performed within the plant. These include cutting to primals; partial deboning; vacuum packaging and boxing; fabrication and packaging for hotel, restaurant and institutional use or for retail store presentation; and processing to produce products such as hams, bacon, prepared meats, etc. The kinds of operations actually carried out in any specific plant will depend on transportation costs to, and distribution costs in, market areas; the cost of performing the operations; location and size of markets; and competition from other firms for the market. The firm's ability to compete for markets will depend on its costs of producing the product, transportation and distribution costs, ability to differentiate its products, etc.

In the Canadian context these decisions take on a number of additional and sometimes unique dimensions. In very general terms 70% of the population is located in Eastern Canada whereas the region contains only 40% of the beef production. One of the imperatives of the beef market is therefore a substantial movement of beef from Western to Eastern Canada. There are major beef feedlot concentrations in southern Alberta and southwestern Ontario. With these two exceptions cattle marketings are relatively sparsely distributed. In addition, beef from dairy industry sources dominates marketings in some regions, particularly eastern Ontario and the province of Quebec.

Within both the pork and beef industries two major product categories can be identified. In the beef industry for example, over 30% is sold as ground meat, about 70% as fresh cuts, and a small proportion as

processed meats. The relationships between the kinds of cattle marketed, potential yields of ground beef and fresh cuts from these cattle, and the demand for the two kinds of meat are relatively complex adding to the difficulty of the task faced by decision makers. By comparison almost 65% of pork is consumed as processed pork products and about 35% as fresh pork cuts. A wide variety of processed pork products are available and, unlike fresh meats, are often marketed under brand names associated with specific packers.

In the case of cattle, about 50% of the live animal weight is sold to consumers as meat and meat products. For hogs the yield is about 60%. By-products such as hides, offal, and tankage are therefore an important consideration in a packer's operations. For small packers rendering and other facilities required for the transformation of by-products into marketable commodities are uneconomical. These facilities are therefore often operated independently or attached to larger plants and draw raw or 'green' by-products from a number of plants.

The application of grades and standards is another important force shaping the industry. Carcasses have traditionally been the most important point of reference in the marketing of both cattle and hogs. All hogs marketed in Canada are sold on the basis of warm carcass weight and grade. The grading system for hogs serves the purpose of providing a formal basis for interchange between producer and packer while the basis for interchange between packers and wholesalers/retailers most often involves fresh primals on terms and conditions not based on formalized standards. Likewise, trade in processed pork products is not based on formalized standards. Cattle are marketed either on a

liveweight basis or according to warm carcass weight and grade. As such the carcass grade plays a somewhat less important role in the marketing of live cattle than it does in the marketing of live hogs. Carcass grade, however, plays a much more important role in transactions between packers and wholesalers/retailers than it does in the pork sector. Increasingly, transactions between packers and retailers involve boxed beef. Although boxed beef specifications usually require that the grade stamp and inspection legend appear on each cut, this method is not entirely satisfactory to retail buyers. Many retail buyers feel that visual inspection of the carcass is required to assure quality and this attitude has impeded boxed beef's penetration of the retail market. Acceptance of boxed beef by retailers is an important parameter which the meat packing industry will have to adjust to in the coming years.

International trade plays an important role in Canada's livestock and red meats sectors. Between 15 and 20% of all pork produced in Canada is exported. Imports of live cattle approached 5% of slaughter in 1981. In contrast, exports of live cattle approached 10% of marketings in 1976. Imported boneless beef represents about 6% of all beef consumption while up to 10% of Canada's beef production is exported. Packers must therefore consider their actions in the context of the trade environment whether it involves their ability to compete with foreign buyers for livestock supplies or with foreign sellers for markets either domestically or internationally.

Finally, public intervention can have, and has had, profound impacts on the industry as a whole and on individual firms. The rapid development of hog production in Quebec is a striking example, but there are many

others. Changes in international trade policy, provincially funded production incentives, and regional development incentives for plant construction/expansion are all factors which packers have to deal with from time to time.

The research problem is, then, to develop a tool which will assist meat packers, processors and distributors to make better decisions concerning their livestock acquisition, fabrication and processing, marketing, and distribution activities given the distribution of livestock production and meat consumption, the kinds of products consumed and the transformations involved in producing them, transportion costs for the various products, various characteristics of the marketing system, the international trade environment, and the vagaries of public intervention.

More specifically, the objective of this study is to develop and demonstrate the capabilities of an investment planning tool for assessment of:

1) Changes in the regional location of livestock production.

2) Changes in the demand for red meats whether caused by population increase or changes in consumer tastes and preferences.

3) Changes in meat packing and processing technology and its adoption by various sectors of the industry, in particular, the increased penetration of boxed beef in retail markets.

4) Changes in the distribution patterns for meats caused by shifts in the regional distribution of population, international trade patterns, transportation costs, or other factors.

5) Changes in the industry's capacity to transform livestock into consumer products whether caused by

construction of a new plant or by discontinuance of operations at existing plants.

The remainder of the study consists of a description of the method used to conduct the study (Chapter III), a description of some of the relevant characteristics of the industry (Chapter IV), a description of the linear programming tableaus used to model the industry (Chapter V), results of the procedures used to validate the model (Chapter VI), and the results of several experiments to determine the effects of changes in major parameters affecting the industry (Chapter VII).

A few notes on terminology are in order. ASSEMBLY refers to collection of live animals to packing plants for slaughter. The terms SLAUGHTER 'packing' and 'kill-and-chill' are used interchangeably to describe the processes involved in transforming a live animal into a hanging and chilled carcass. The term FABRICATION is used to describe any process which involves cutting or trimming meats. PROCESSING refers to any process involving cooking, curing, mixing or spicing meats. DISTRIBUTION refers to either long distance transfer in truck or car lot units, or final distribution to retail outlets by medium duty trucks.

CHAPTER III: RESEARCH METHOD

Use of the linear programming technique to derive a set of product flows and transformations which would minimize the aggregate cost of assembling livestock, processing into meat products, and distributing meats to consumers has been the foundation of the project since the work leading up to the submission of the unsolicited proposal. In this chapter the development and refinement of this concept is reviewed.

Immediately following project commission, meetings were held with industry representatives to familiarize them with the project, solicit their co-operation, and explore actual and anticipated developments in the industry. These concerns and potential issues were to be taken into consideration during the design and development of the investment planning tool.

The issues identified by the industry included: declining competitiveness in relation to packers in the United States; transportation issues including the impact of changes in statutory rates for movement of Prairie grains and rapidly increasing rates for livestock and meat transportation; the impact of various provincial stabilization, tax, and credit initiatives aimed at the livestock sector; and possible changes in tariff and non-tariff barriers to international trade.

Governments identified possible areas in which the tool could be used for policy analysis: evaluation of submissions to DREE for construction

of meat packing facilities; evaluation of regional effects of specific plant closures; exploration of policy alternatives to promote rationalization of the meat packing and distribution system; and the evaluation of feed grain policy alternatives.

After these initial meetings with the industry and government, work began in three major areas: collection of required data from published sources; the development of a packer/processor questionnaire that would help fill data requirements which could not be met from published sources; and the detailed specification of programming tableaus.

The major information requirements for development of the model were defined as follows:

1) The regional distribution of livestock marketings.

2) Livestock movements from farms to slaughter plants, and associated costs.

3) The costs of slaughtering livestock, and of cutting and processing meats.

4) The flows of meat from point of slaughter to alternative processing facilities and/or to retail outlets, and associated costs.

5) The regional disappearance of red meats.

Questions regarding operating costs were very general in the packer questionnaire. Their purpose was to elicit the 'rules of thumb' which managers use to guide their daily operations. Similarly, detailed cost component breakdowns were not solicited. This approach was taken in the questionnaire because it was felt that more useful information could be obtained in less time and at less expense by taking a 'financial modelling' approach. The cost information obtained in the questionnaire

was used subsequently to verify the results of this approach.

Financial models of typical plants were developed to provide the detailed cost structures required to evaluate questions of economies of scale in slaughter and processing, regional differences in processing cost, and costs attributable to specific processes. The beef plant synthesis follows closely the work of Cothern [8] on economies of scale for beef slaughter in California. That study was adapted to Canadian conditions and a boxing operation added with the help of associate consultants. A similar approach was taken to the development of pork plants although no published material on the subject was available. The synthesized pork plants include slaughter and cutting to primal activities only and were developed with the assistance of an associate consultant with extensive experience in the industry.

There is very little published data available on the movement of meats. The only source of information on this aspect of activity in the industry came from a series of specific and detailed questionnaires in the packer survey. Although this information was not essential for the proper functioning of the model, as clear a picture as possible was essential to the validation process. Adequate information on per capita disappearance of red meats is available at the national level, but not at the regional level. This left two alternatives for the development of regional disappearance: assume homogenous consumption so that consumption varies only with population or, attempt to estimate regional differences using Statistics Canada Family Food Expenditure Surveys and/or market research studies available from industry sources. The latter option was explored and found to be feasible but unreliable.

The data accumulated was as far as possible relevant to the 1981 calendar year. There were several reasons for this choice: at the time that data collection began the latest available annual data applied to the 1981 calendar year, the most recent fiscal year for which companies would have financial results would be those ending in late 1981 or early 1982, and accurate population estimates for mid 1981 were available as a result of the census.

After data availability had been assessed the questionnaire design was completed, the questionnaire was pre-tested, refined, translated into French and distributed to potential respondents. Once the questionnaire was in the field a progress report was prepared and presented. Work then began on the development of the appropriate programming tableaus.

An integral part of the process used to define the final form of the tableaus was the development of experimental tableaus involving only two regions. The experimental tableaus provided an inexpensive way to refine the internal logic of the tableaus and test alternate formulations.

A total of 54 completed questionnaires were received comprising 36 beef and 18 hog slaughter plants (see Table III.1).

Overall, packer participation in the survey was mixed. Two major nationally based firms did not participate. Several sizable provincially based packing plants and a number of smaller plants also declined to participate in the study for reasons of confidentiality, because of the time required to gather and summarize the information requested in the questionnaire, or simply because they did not perceive

TABLE III.1: COMPLETED QUESTIONNAIRES RECEIVED

Region	--- Number of Responding Firms --- Cattle	Hogs
British Columbia	1	2
Alberta	7	2
Saskatchewan	1	0
Ontario	13	4
Quebec	8	5
Atlantic Provinces	6	5
TOTALS	36	18

any benefit to themselves from participating in the study.

Although survey response was insufficient to provide reliable estimates of differences in processing costs between regions and between plant sizes, it provided adequate information on costs of processing, product yields from the various processing activities, and transportation and distribution costs. It also provided information on movements of meats and meat products which was useful in the validation of the model. A second progress report was prepared and presented after the survey results had been analyzed and the experimental models completed. Work then began on financial modelling studies of beef and pork plants and on expansion of the experimental tableaus into a full sixteen region formulation.

Validation of the two models was then carried out and once a satisfactory validation had been achieved several experiments were conducted using the models.

CHAPTER IV: CHARACTERISTICS OF THE INDUSTRY

In Chapter I the definition of the economic problem included a brief description of several important features of the industry, its importance to the economy in terms of employment and value added, mounting economic pressures due to increasing transportation costs, changes in processing and distribution technology, and major changes in industry throughput. The purpose of this chapter is to develop these themes further and provide a full description of the environment within which the industry operates.

IV.1 LIVESTOCK PRODUCTION

Among the most important factors affecting the industry in the past ten years have been substantial changes in the level and geographic distribution of livestock production and slaughter. Table IV.1 shows federally inspected cattle and hog slaughter in Canada since 1972. Cattle slaughter increased by almost 30% between 1974 and 1977 and then fell an equal amount between 1977 and 1979. Slaughter levels have increased somewhat since 1979 but excess capacity has plagued the industry since that time as evidenced by numerous bankruptcies and plant closings both in Eastern and Western Canada. There have been even more dramatic changes in the level of hog slaughter. Between 1976 and 1980 hog slaughter increased by 70% and has remained at approximately 1980

levels until the present time. Although some of the increase can be attributed to cyclical factors, there has also been an undeniable shift to a higher overall level of hog production in Canada in the last decade.

TABLE IV.1: FEDERALLY INSPECTED CATTLE AND HOG SLAUGHTER IN CANADA, 1972 TO 1983

Year	Cattle Slaughter (000 head)	Index (1972=100)	Hog Slaughter (000 head)	Index (1972=100)
1972	2,879	100	9,367	100
1973	2,878	100	8,722	93
1974	2,976	103	8,939	95
1975	3,338	116	7,656	82
1976	3,676	128	7,493	80
1977	3,761	131	8,007	85
1978	3,430	119	8,934	95
1979	2,954	103	11,031	118
1980	3,059	106	12,927	138
1981	3,197	111	12,844	137
1982	3,258	113	12,564	134
1983 (est)	3,250	113	12,743	136

There have been only minor changes in the geographic distribution of cattle production (see Table IV.2) since 1972. Cattle marketings in Saskatchewan fell from about 16 to about 9% of the national total. There was also a small decline in Manitoba's share and small increases in B.C., Alberta and Quebec. Changes in the geographic distribution of hog marketings have been much more dramatic (see Table IV.3). Quebec's share of marketings increased by 15%, from 20 to 35 percent of the national total. Ontario and the Atlantic provinces maintained

approximately the same share of national marketings. All three Prairie provinces experienced declining shares: Alberta fell from 20 to 12%, Saskatchewan from 11 to 5%, and Manitoba from 13 to 9%. British Columbia increased its share from less than 1% to over 2%. Overall, hog marketings have fallen slightly in Western Canada but risen dramatically in Eastern Canada. Marketings in Eastern Canada have risen from 55 to 70% of the national total. As a result the slaughter industry has been characterized by excess capacity and plant closings in Western Canada, and the construction of a number of medium and large scale hog slaughter facilities in the province of Quebec.

Another important factor determining the kinds of operations carried out at packing plants and the products produced is the composition of cattle marketings. Specifically, cows, bulls and lower grade heifers and steers are suitable only for the production of ground beef, weiners, bologna, and other processed meats. Top grade heifers and steers are used for the production of fresh cuts although trim and perhaps some of the lower quality cuts from the carcass are sold as ground beef. Figure IV.1 shows the type composition of cattle marketing by province. The most striking feature is the mix of fed and non-fed marketings in Quebec where 75% of cattle marketed are cows or bulls. In most other provinces non-fed cattle represent less than 35% of marketings. At the other end of the spectrum are Alberta and Ontario where non-fed cattle are only about 15% of total marketings. Although marketings from the dairy herd in Ontario are substantial, the ratio remains low because of the large numbers of feeder cattle and calves of western origin which are fed in Ontario.

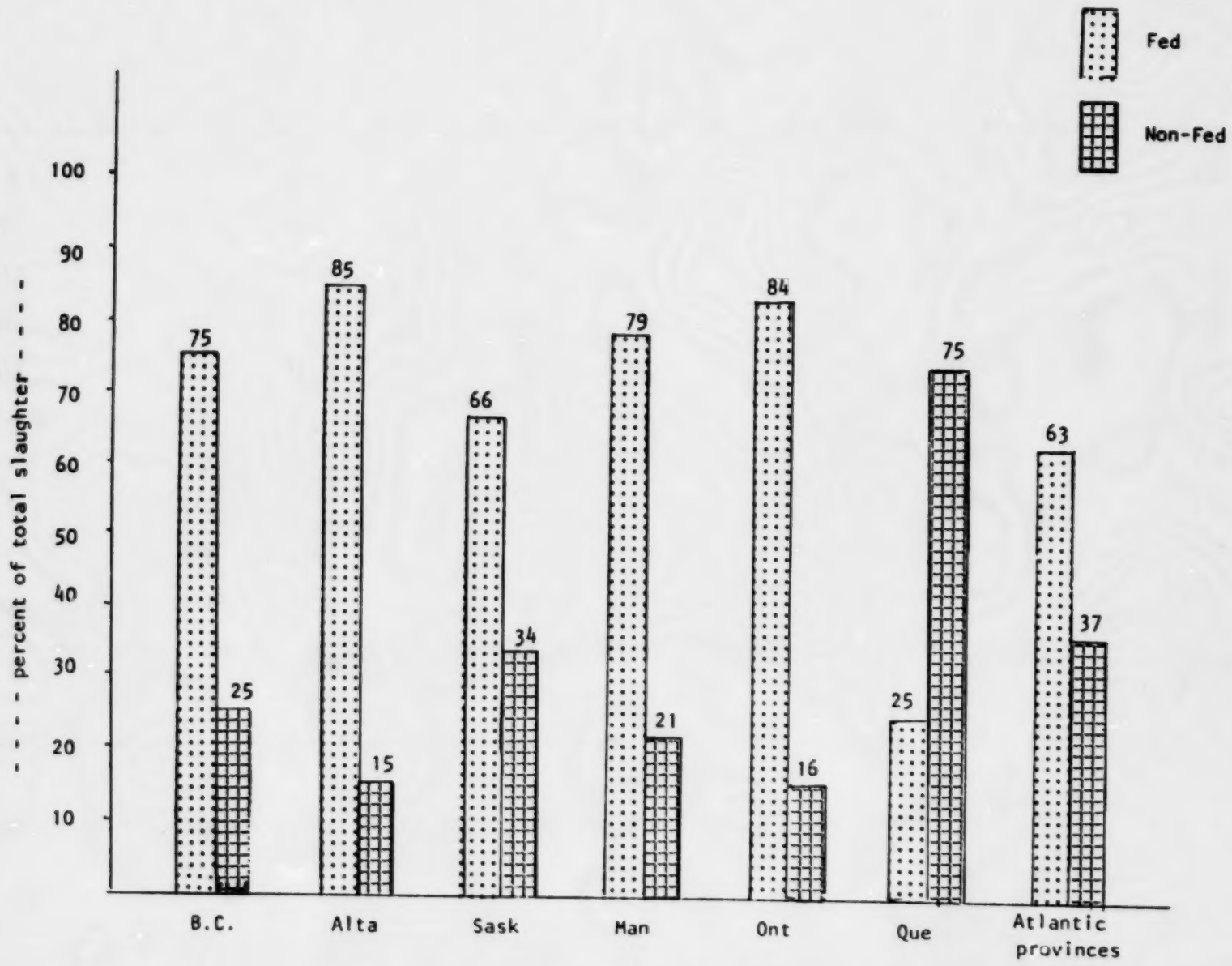
TABLE IV. 2. : PROVINCIAL SHARES OF CATTLE MARKETINGS IN CANADA, 1972 to 1981 (Percent of Total)

	B.C.	Alta	Sask	Man	Western Canada	Ont	Que	Atlantic	Eastern Canada
	----percent of total cattle marketed----								
1972	1.3	37.3	16.0	9.1	63.7	30.1	4.8	1.4	36.3
1973	2.0	38.5	14.9	9.2	64.6	29.7	4.3	1.4	35.4
1974	2.2	38.7	15.5	9.5	65.8	29.8	3.3	1.1	34.2
1975	2.4	40.0	14.8	9.4	66.6	28.2	3.8	1.5	33.4
1976	1.9	41.5	13.5	9.3	66.1	27.8	4.7	1.4	33.9
1977	1.7	41.1	11.9	9.5	64.3	29.6	4.7	1.4	35.7
1978	1.9	40.2	10.4	9.5	62.0	31.0	5.5	1.5	38.0
1979	1.9	42.0	9.0	8.9	61.7	31.4	5.5	1.5	38.3
1980	2.2	41.1	9.2	8.5	60.9	31.4	6.2	1.5	39.1
1981	2.4	42.3	9.2	8.0	61.9	30.1	6.5	1.5	38.1

TABLE IV. 3: PROVINCIAL SHARES OF HOG MARKETINGS IN CANADA, 1972 to 1981 (Percent of Total)

	B.C.	Alta	Sask	Man	Western Canada	Ont	Que	Atlantic	Eastern Canada
	------Share of total hog marketings (per cent)-------								
1972	0.6	20.1	11.7	13.1	45.5	31.1	19.9	3.4	54.5
1973	0.6	19.0	11.9	14.0	45.4	30.2	20.9	3.5	54.6
1974	0.8	17.8	11.0	13.5	43.0	29.5	24.3	3.3	57.0
1975	0.9	15.7	7.8	11.2	35.5	31.5	29.3	3.7	64.5
1976	0.7	14.1	7.0	10.8	32.7	33.3	30.4	3.7	67.3
1977	1.0	14.3	6.5	10.4	32.2	32.2	31.8	3.7	67.8
1978	1.1	13.3	6.1	9.7	30.1	33.1	33.1	3.7	69.9
1979	1.2	12.5	5.7	9.6	29.0	33.6	33.8	3.5	71.0
1980	2.0	12.6	5.8	9.4	29.7	31.6	35.2	3.5	70.3
1981	2.6	12.2	5.1	9.3	29.1	31.0	36.0	3.9	70.9

FIGURE IV. 1.: COMPOSITION OF CATTLE MARKETING BY PROVINCE



IV.2 DEMAND FOR MEATS

The foregoing discussion has outlined some of the important characteristics of livestock supply. The other side of the coin is the regional distribution of demand. In very general terms combining the distributions of supply and demand provides a picture of the types of flows required to balance the two. Table IV.4 summarizes the regional distribution of population (demand) and livestock marketings and slaughter (supply). Several observations can be made:

- British Columbia is deficit in both cattle and hog production.
- Alberta is surplus in both cattle and hogs; the cattle surplus is pronounced (at least 4 times the requirements based on population).
- Saskatchewan and Manitoba are surplus in both cattle and hogs.
- Quebec is surplus in hogs but has a marked deficit in cattle (only about 1/4 of requirements based on population). The beef deficit is even more pronounced where high quality cuts are concerned because of the high non-fed component of marketings.
- The Atlantic provinces are deficit in both cattle and hogs.
- Cattle marketings in Alberta and Saskatchewan are higher than slaughter. The difference goes to export and to Manitoba for slaughter.
- Cattle marketings in Ontario and Quebec are lower than slaughter. The difference comes from cattle imported for slaughter. To some extent this feature is a result of the year chosen (1981). The import/export balance for live cattle varies considerably from year to year.
- Hog marketings and slaughter match closely on a provincial basis. There are minor interprovincial movements from Saskatchewan to Alberta, Manitoba to export, and (Eastern) Ontario to Quebec.

TABLE IV.4: PRODUCTION, SLAUGHTER, AND CONSUMPTION INDICATORS FOR THE BEEF AND PORK SECTORS IN 1981, BY PROVINCE

	- - - Cattle - - -			- - - Hogs - - -	
Province	% of Cattle Marketings	% of Cattle Slaughter	% of Human Population	% of Hog Marketings	% of Hog Slaughter
British Columbia	2.38	2.24	11.31	2.58	2.55
Alberta	42.32	39.73	9.22	12.18	13.09
Saskatchewan	9.15	6.52	3.99	5.07	4.10
Manitoba	8.02	9.45	4.23	9.27	8.78
Ontario	30.07	32.41	35.53	31.00	29.83
Quebec	6.55	8.00	26.52	36.02	37.83
Atlantic Provinces	1.51	1.65	9.20	3.88	3.82
Totai	100.0	100.0	100.0	100.0	100.0

Source: Livestock Market Review, 1981. Agriculture Canada
1981 Census of Canada

identified in the beef (cuts versus ground beef) and pork (cuts versus processed products) sectors. The 1978 Urban Family Food Expenditure Survey conducted by Statistics Canada sheds some light on this subject as well as giving some indication of regional differences in consumption patterns. About 33% of beef purchases for home consumption are in the form of hamburger. The remaining 67% consists largely of fresh cuts. There is considerable variation between cities, however, from a low of 23.5% of purchases as hamburger in St. John's Newfoundland to a high of 39.5% in Saint John, New Brunswick. Differences between regions in overall levels of consumption are also evident. Quebec City, Montreal and Winnipeg are well above the national average, whereas Ottawa, Toronto, Regina, and Saskatoon are well below it. About 35% of pork purchases for home consumption are in the form of fresh cuts. The remaining 65% are in the form of processed pork products. There is considerable variation between cities, from a low of 20.9% of purchases as fresh cuts in Quebec City to a high of 44.9% in St. John's Newfoundland.

Differences between regions in overall levels of consumption are also evident. St. John's, Quebec City, Ottawa, Thunder Bay and Regina are above the national average; Charlottetown, Montreal, Toronto, Saskatoon, and Calgary well below it. 1/

1/ Although comparisons between cities are interesting, definitive conclusions should be avoided. The nature of the survey, the fact that purchases rather than consumption is being monitored, the fact that specific food purchases away from home are included, and the fact that rural population is not included in the survey, all dictate against the drawing of valid conclusions about consumption of these products.

Again, in very general terms, these distributions of supply and demand imply:

- Net movements of beef and pork products into B.C.
- Net movements of beef and pork products out of the Prairie region, with beef movement out of Alberta a prominent feature.
- Net movements of beef and pork products into Ontario and the Atlantic provinces.
- Net movement of pork products out of, and a substantial movement of beef products into, Quebec.

Except to the extent that imports, exports and storage stocks of meat products change, consumption reflects many of the same patterns as production. The apparent per capita consumption of meats is shown in Table IV.5 and Figure IV.2. Disappearance of beef shows the same rapid increase from 1974 to 1976 as cattle marketings, and the same rapid decline from 1976 to 1979. Disappearance of pork shows the cyclical pattern characteristic of the pork sector. Although hog marketings increased about 70% from 1976 to 1980, disappearance increased only about 30%. The difference has gone to significantly increased exports of live hogs and pork products to the United States. The steady increase in the consumption of 'other' meats is largely due to increasing consumption of poultry meats. Pork production has averaged about 60% of beef consumption in the last two decades but wide fluctuations are evident. In 1976 beef consumption was more than double pork consumption. In 1980 beef consumption was only 20% above pork consumption.

Of somewhat greater interest in the current context is information on the consumption of the two major product groupings which have been

TABLE IV. 5 : APPARENT PER CAPITA DISAPPEARANCE OF BEEF, PORK AND OTHER MEATS IN CANADA, 1963 to 1982.

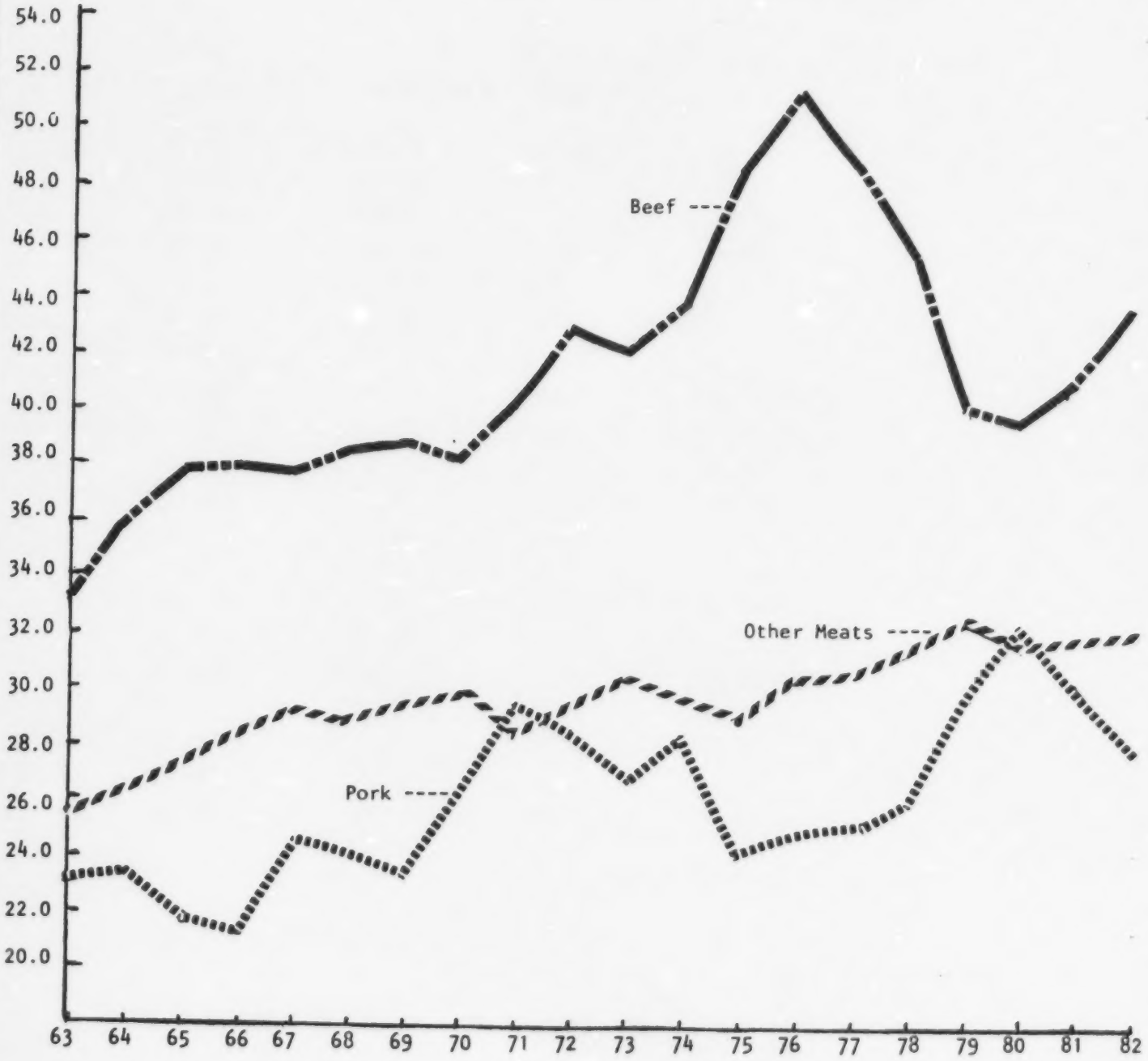
	Beef	Pork	Other Meats[1/]	Total
	---Kilograms/head of population---			
1963	33.71	23.00	25.70	82.41
64	36.01	23.49	26.49	85.99
65	37.91	21.71	27.43	87.05
66	38.11	21.31	28.45	87.87
67	37.72	24.73	29.16	91.61
68	38.62	24.26	28.94	91.82
69	38.85	23.32	29.63	91.80
1970	38.29	26.65	29.90	94.84
71	40.18	29.47	28.61	98.26
72	42.77	28.63	29.52	100.92
73	42.05	26.88	30.38	99.31
74	43.67	28.18	29.61	101.46
75	48.53	24.18	29.02	101.73
76	25.10	30.55	30.55	107.00
77	48.93	25.18	30.58	104.69
78	45.75	26.19	31.38	103.32
79	40.01	29.70	32.37	102.08
1980	39.75	32.30	31.55	103.60
81	40.95	30.29	31.77	103.01
82	40.43	27.90	31.93*	100.26*

1/ Veal, Mutton and Lamb, Poultry Meats, Fish

* Estimated

Source: Statistics Canada, Apparent per Capita Food Consumption in Canada, Catalogue 32-226

FIGURE IV. 2.: APPARENT PER CAPITA DISAPPEARANCE OF BEEF, PORK, AND OTHER MEATS IN CANADA, 1963 to 1982. (kilograms/head)



IV.3 STRUCTURE OF THE PACKING AND PROCESSING INDUSTRY

The functions of transforming live animals to consumable products and transferring products to satisfy consumer demand in each region are performed by the slaughter, processing and distribution sectors of the industry. The purpose of the discussion in the following paragraphs is to examine the structure and characteristics of these sectors.

The 1980 census of manufacturers identifies 547 enterprises engaged in slaughtering and meat processing (see Table IV.6). Over 300 of these are small businesses. As measured by number of employees, Ontario benefits from the largest proportion of economic activity in this sector. Within Ontario, the activity is concentrated almost entirely in the central region. Quebec, Alberta, and Manitoba also experience considerable economic activity from the industry. Overall, the industry paid over 450 million dollars in wages; spend over 5.7 billion for materials, supplies and energy; and sold almost 7 billion dollars worth of goods. These statistics do not include the activities of some elements of the distribution sector and almost none of the activities of the retail sector.

The largest firm in the industry is Canada Packers which operates on a national scale with major plants in Vancouver, Edmonton, Red Deer, Calgary, Lethbridge, Moose Jaw, Winnipeg, Toronto, Montreal and Charlottetown. The company's plants are of various types. The Toronto, Winnipeg and Calgary facilities can perform a full spectrum of slaughter and processing activities for both cattle and hogs. The Lethbridge and Red Deer plants are specialize in the slaughter function and ship only

TABLE IV. 6 : PRINCIPAL STATISTICS OF THE MANUFACTURING ACTIVITIES OF SLAUGHTERING AND MEAT PROCESSORS, 1980

	Excluding small business	Number of establishments	Production and related workers			Cost of fuel and electricity(1)	Cost of materials and supplies(1)	Value of shipments of goods of own manufacture	Value added
		Total	Number	Thousands of man-hours paid	Wages				
	- - - - - - - - - thousands of dollars - - - - - - - - -								
Newfoundland	2	4	x	x	x	x	x	x	x
P.E.I.	2	5	x	x	x	x	x	x	x
Nova Scotia	3	9	x	x	x	x	x	x	x
New Brunswick	3	6	375	770	5,088	x	54,360	69,804	13,869
Quebec	86	142	6,313	13,215	97,622	16,725	1,301,013	1,547,179	236,909
Ontario	74	189	10,099	21,369	183,257	20,556	1,980,367	2,600,887	603,146
Manitoba	15	37	2,108	4,294	37,646	4,190	398,278	470,928	71,387
Saskatchewan	11	39	1,111	2,280	15,574	1,842	225,693	290,771	60,801
Alberta	31	72	4,344	8,752	80,877	6,202	1,456,082	1,565,983	105,033
British Columbia	15	44	1,755	3,609	31,152	2,082	246,796	324,944	77,554
Yukon and NWT	-	-	-	-	-	-	-	-	-
Canada	243	547	26,610	55,324	458,464	54,342	5,719,259	6,944,216	1,184,547

Source: Slaughtering and Meat Processors, 1980. Statistics Canada, Catalogue 32, 221.

one major product: carcass beef. The Vancouver and Montreal plants do not perform the slaughtering function at all, restricting their activity to cutting and processing meats.

Burns/Canadian Dressed Meats is another major national firm with plants in Calgary, Lethbridge, Brandon, Winnipeg, Toronto and Kitchener. While Gainers/Swift is a third major national firm it is difficult to describe its current structure given the current rationalization of the firm's meat processing activity. In 1981, the company operated plants in Edmonton, Lethbridge, Kitchener and Toronto. The Heritage Group (J.M. Schneider) operates a major plant in Kitchener and other plants in Winnipeg and Vancouver.

There are a number of important regional firms such as Intercontinental Packers (Saskatoon, Regina, and Vancouver), Fletcher's (Red Deer and Vancouver), Co-op Federee de Quebec (Princeville, Valle Junction, Ville d'Anjou), and the Olympia group (Princeville, St. Simon).

Single-plant firms are numerous and many operate medium to large-scale plants. examples are Dvorkin, Centennial, Lakeside, and XL in Alberta; Fearman, Tender-Lean, and Windsor Packing in Ontario; St. Valerien, Abatoir du Nord, Abattoir St. Jean, and Abattoir Ouellet in Quebec.

There are also a large number of smaller single-plant firms some of which play an important role in servicing the needs of small, isolated concentrations of livestock. Examples would be Grand Prairie Packers (the Peace River district of Alberta), Lawrence Meat Packing (Dawson Creek, B.C.), Chaine Co-op du Saguenay (Lac St. Jean, Quebec), Hub Meat Packers (Moncton), and Chippin Bros (Fredericton).

Other important types of operations are:

- meat processing, an area in which a large number of small firms compete effectively with major packers with processed lines (Schneider, Canada Packers) and larger specialist firms with national distribution (Coorsh, Hygrade);
- fabrication by retail chains at central cutting facilities (Lucerne in Calgary, Steinberg in Montreal and Toronto);
- fabrication or processing by HRI distributors (Caravelle Foods in Ontario and Alberta, Ponderosa, F.G. Bradley, etc.). Like processed meats, this is an area in which smaller firms appear to compete effectively with larger scale operations.

An analysis of registrations under the Canada Meat Inspection Act sheds some additional light on the structure of the industry (see Table IV.7). The ability of small firms to compete in fabrication and processing is evident with almost 500 establishments involved in these activities but only about 100 establishments involved in slaughtering. Quebec has a large number of establishments in relation to the livestock population of the province. The pork sector in Quebec is characterized by a relatively small number of large and modern plants. The cattle sector however, is characterized by a very large number of small facilities for slaughter of local dairy cattle.

Several other features of the industry can be seen in an analysis of the industry's shipments (see Table IV.8). Shipments of fresh and frozen beef at 45% of total sales is by far the biggest category. This is somewhat exaggerated, however, because inter-establishment trading in fresh beef (which leads to double counting of revenues) is more common than in pork or other meats. The low proportion of fresh and frozen

TABLE IV.7 : REGISTERED ESTABLISHMENTS OPERATING UNDER THE CANADA MEAT INSPECTION ACT AND REGULATIONS, APRIL 1982

Province	Any Meat Packing Establishment	Just Slaughter (S)	Slaughter & Process (SP)	Wholesale Cut-up (WCU)	Processed Meats (PRM)
British Columbia	23	1	5	12	19
Alberta	34	7	9	16	24
Saskatchewan	6	--	4	5	1
Manitoba	17	3	3	9	14
Ontario	120	4	19	49	103
Quebec	187	24	18	73	130
New Brunswick	10	--	2	6	8
Nova Scotia	7	--	2	6	4
Prince Edward Island	1	--	1	1	1
Newfoundland	4	--	2	3	3
Canada	409	39	65	180	307

TABLE IV.8: SHIPMENTS OF GOODS OF OWN MANUFACTURE, SLAUGHTERING AND MEAT PROCESSING ESTABLISHMENTS, 1980

PRODUCT	Quantity (MT)	Value ($000)	% of Total Value of Shipments
Beef			
Fresh or Frozen	985,166	3,142,870	45.44
Cured	6,384	19,656	.28
Smoked	8,580	54,361	.79
Tallow	391,318	188,586	2.73
Pork			
Fresh or Frozen	733,760	1,320,885	19.10
Cured	13,060	38,647	.55
Smoked	163,215	458,410	6.63
Canned	7,640	30,349	.44
Lard	60,314	48,532	.70
Other Meats[1/]			
Fresh or Frozen	105,399	266,265	3.27
Animal Feed (Raw Meat)	22,612	5,411	.08
Meat preparations	219,395	871,807	12.60
Tankage and similar products	525,993	142,007	2.05
Hides - Cattle 3,155,060		103,579	1.50
- Other 540,152		5,908	.09
Other products	28,843	259,398	3.75
	3,271,679	6,916,671	100.0

Note: Approximately 25% of meat purchases are inter-establishment or imports

1/ includes veal, mutton, lamb, horse, poultry and other.

Source: Slaughtering and Meat Processors, Statistics Canada, Catalogue 32-221.

pork (19%) is consistent with earlier comments about the importance of processed pork products. When smoked pork (6.6% of revenues) and meat preparations (12.6%) which are largely pork based are added to the fresh percentage, pork products account for 35% of industry revenue. Only 3% of industry revenue comes from the sale of meats from other livestock. By-products (tallow, lard, animal feed, tankage, hides, and other products) account for about 10% of industry sales.

Any consideration of the current structure of the industry leads inevitably to questions about 'optimum' structure. Table IV.9 and IV.10 attempt to put the question into the context of current livestock marketings and plant numbers. These simple comparisons have their limitations. Medium or large scale plants may not be 'optimal' given the geographic distribution of livestock marketings within a province. Alternatively, the benefits of maintaining an element for competition may make two smaller plants preferable to a single larger one in any given region. Nevertheless, these comparisons serve to set the stage for consideration of questions about optimum structures.

Only Ontario and Quebec have sufficient marketings to support more than two large scale hog slaughter plants. Alberta and Manitoba could support one each. Saskatchewan and the Atlantic provinces could support one medium scale plant each. B.C. marketings cannot support even one medium scale plant. In every case, except Ontario, the number of major plants operating in 1981 far exceeds even the number of medium scale plants required to slaughter the hogs marketed.

Only Alberta and Ontario have sufficient marketings to support more than two large scale cattle slaughter facilities. Saskatchewan, Manitoba and

TABLE IV.9 : NUMBER OF MEDIUM OR LARGE SCALE PLANTS REQUIRED TO SLAUGHTER CATTLE MARKETED IN 1981, BY PROVINCE

	Cattle Marketings	- No. of Plants Required - medium scale[1/]	large scale[2/]	Number of Plants Operating in 1981
British Columbia	74666	.5	.4	4
Alberta	1326026	9.4	6.4	12
Saskatchewan	286714	2.0	1.4	4
Manitoba	251295	1.8	1.2	5
Ontario	942325	6.7	4.6	23
Quebec	205159	1.5	1.0	15
Atlantic Provinces	47148	.3	.2	6

1/ Medium scale is 75 head/hr, 2800 head/week, or 140,600 head per year. There are several plants of this scale operating in Canada.

2/ Large scale is 110 head/hr, 4125 head/week, or 206,250 head per year. There are fewer than five plants of this scale operating in Canada.

TABLE IV.10: NUMBER OF MEDIUM OR LARGE SCALE PLANTS REQUIRED TO SLAUGHTER HOGS MARKETED IN 1981, BY PROVINCE

	Hog Marketings	- Number of Plants Required - medium scale[1/]	large scale[2/]	Number of Plants Operating in 1981
British Columbia	338982	.8	.3	5
Alberta	1601314	3.6	1.4	6
Saskatchewan	667404	1.5	.6	4
Manitoba	1219619	2.7	1.1	5
Ontario	4077587	9.1	3.6	9
Quebec	4737565	10.5	4.2	17
Atlantic Provinces	510257	1.1	.5	7

1/ Medium scale is 240 head/hr, 9000 head/week, or 450,000 head per year. There are several plants of this scale operating in Canada.

2/ Large scale is 600 head/hr, 22,500 head/week, or 1,125,000 hogs per year. There are fewer than five plants of this scale operating in Canada.

Quebec could support one each. B.C. and the Atlantic provinces could not support even one medium scale plant. In every case the number of major plants operating in 1981 far exceeds even the number of medium scale plants required to slaughter the cattle marketed.

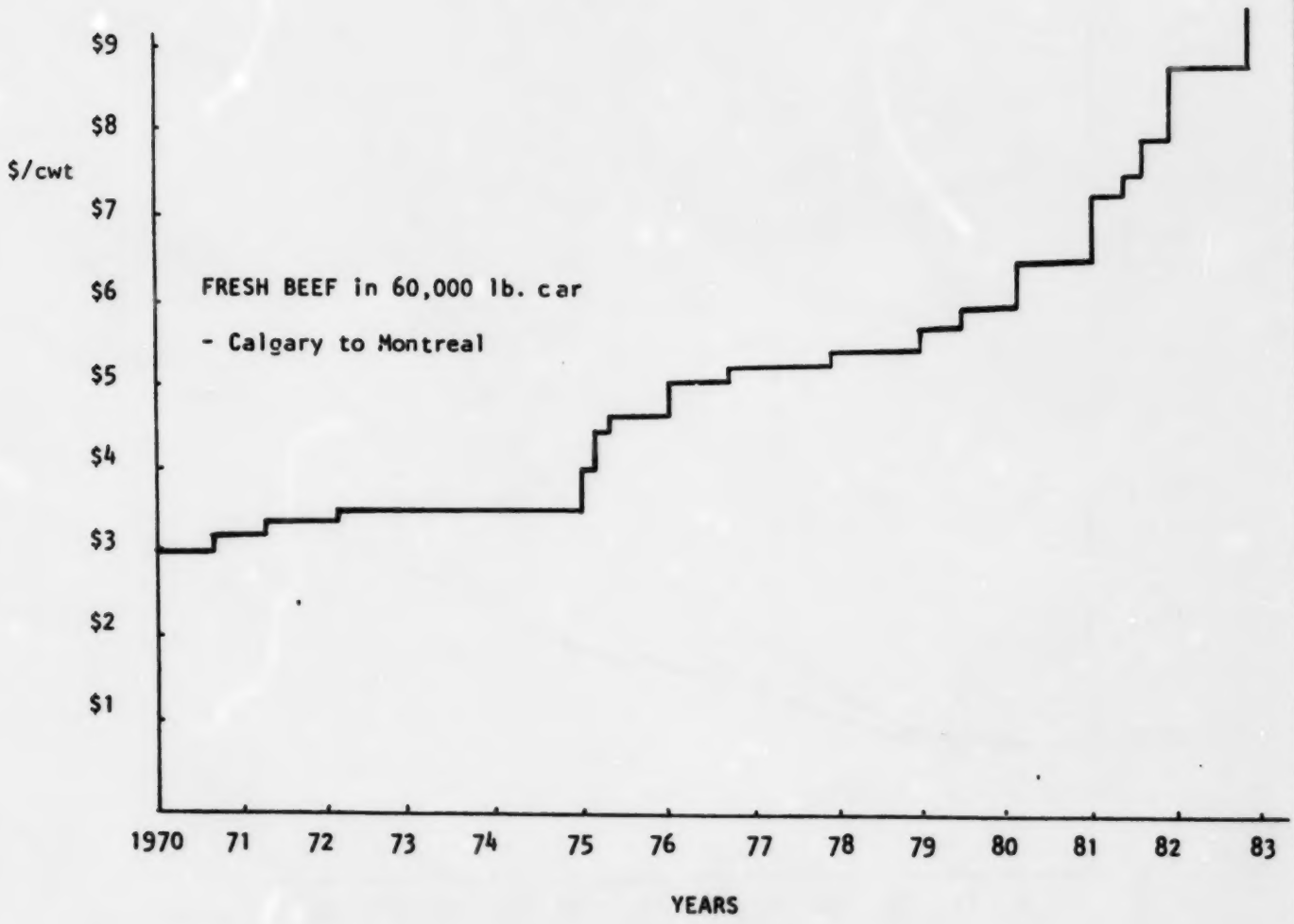
These comparisons should not be taken as an indication that excess capacity exists in every region. Indeed, as shown in the discussion of slaughter capacities in Chapter VII, there are serious problems of both over- and under-capacity to be found in different regions.

IV.4 TRANSPORTATION

Energy costs have increased dramatically over the last decade and with them, the costs of transporting both livestock and meats (see Figures IV.3 and IV.4). Three possible repercussions of these changes which are important in this study are:

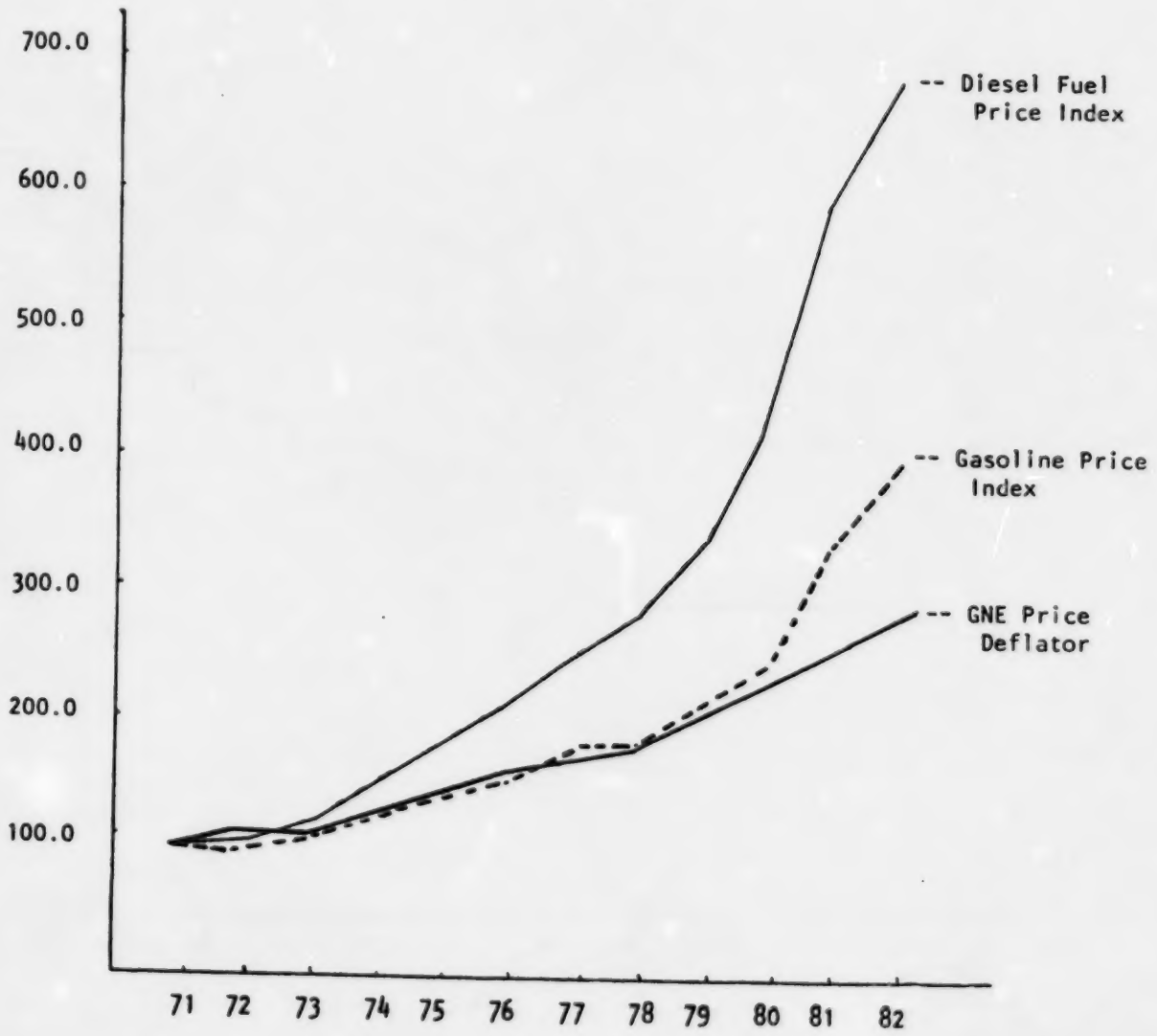
- Higher transportation costs offset the economies of scale advantages associated with larger plants. Slaughter facilities, which involve significant weight reduction, will tend to become smaller, more numerous, and closer to the supply of raw product in an industry where the raw product (livestock) and markets for final products both have a wide geographic distribution.
- There will be increased pressure to transport lighter forms of the product, i.e. to transport boxed rather than carcass beef.
- U.S. suppliers will become increasingly competitive in major Canadian markets because their supply is geographically closer, i.e. Omaha is closer to Montreal than is Calgary.

FIGURE IV.3:- TRANSPORTATION COSTS FOR CARCASS BEEF IN 60,000 lb. CARLOTS, CALGARY TO MONTREAL, 1970 TO 1983



SOURCE: Canadian Meat Council

FIGURE IV. 4. TRANSPORTATION COST INDICATORS 1971 = 100



IV.5 BOXED BEEF

One feature which is unique to the beef sector is the practice of 'boxing' meat for shipment. The process involves breaking the carcass into fifteen different primal cuts, sealing them in evacuated ('Cryovac') plastic bags (26 per carcass), and placing them in boxes (8 per carcass) for shipment. Excess fat is trimmed from the primals and several bones removed resulting in a 'boxed' product which weighs approximately 20% less than the initial carcass. The advantages of performing this additional function at the packing plant are:

- increased labour efficiency in the plant as opposed to the retail store;
- reduced shrinkage and discolouration;
- better utilization of by-products (fat and bone);
- reduced transportation cost.

In spite of these advantages Canadian retailers have been slow to adopt the practice of purchasing boxed rather than carcass beef. Perhaps the most important reason for this is the retailer's need to be assured of the quality of the product he purchases. Carcasses lend themselves to visual inspection whereas boxed product does not. Retailer's may also be reluctant to change because it will make many of their retail meat handling facilities obsolete, or because they face pressure from unions unwilling to give up in-store jobs. Whatever the causes, the adoption of boxed beef by Canadian retailers has lagged well behind that by their counterparts in the United States. Limited information on trends in the two countries is presented in Table IV.11. In 1982 retail penetration

Table IV.11: ESTIMATED PENETRATION OF VACUUM PACKED ("Boxed") BEEF IN THE RETAIL AND HRI SECTORS

Region	1973/74	- - - 1982 - - -		- - - 1985 - - -	
	Penetration	Penetration	Share of Consumption	Penetration	Share of Consumption
USA					
HRI:	--	90%	45%	93%	48%
Retail:	--	70%	55%	72%	52%
Total:	31%	79%	--	82%	--
Canada					
Retail					
Ontario	--	31%	--		
Maritimes	--	11%	--		
Quebec	--	38%	--		
West	--	61%	--		
Total	30%	40%	67%		
HRI	--	45%	33%		
Total	--	43%	--		

Sources: Commission of Inquiry into the Marketing of Beef and Veal
CRYOVAC Division of W.R. Grace and Co.

in the U.S. reached 70% but was only about 40% in Canada. Western Canada has been more progressive in this regard, with penetration at about 60%. Retail penetration has been lowest in Ontario (31%) and the Atlantic provinces (only 7%).

Boxed beef penetration in the HRI sector continues to be higher than in the retail sector in both countries. Projections for 1985 prepared for the W.R. Grace Company indicate that in the United States boxed beef penetration will increase to 93% in the HRI sector and 72% in the retail sector.

Although not necessarily applicable to the Canadian situation, the conclusions of the Grace study in the United States are of interest:

- The trend to further fabrication is likely to continue with an increase in vacuum packaged boneless subprimals.
- An increasing amount of beef is expected to reach the supermarket by way of the distribution center rather than directly from the packer.
- Retailers will purchase an increasing proportion of their beef in the form of vacuum packaged subprimals.
- Retailers indicate a strong desire for pre-packaged case-ready retail cut or a retail-ready bulk package.

CHAPTER V: CHARACTERISTICS OF THE MODEL

The purpose of this chapter is to describe in detail the analytical framework used to undertake the analysis. Although the problem was initially visualized as considering both the beef and pork sectors simultaneously it became increasingly apparent from interviews with packers that there are few opportunities for interface between these two sectors. The biggest potential advantages of locating beef and pork plants at one site appears to be in reduced distribution costs by combining both meats in trucks performing final distribution to retail store and HRI customers. At the slaughter level opportunities to use facilities for both kinds of animals is limited to only the smallest scale plants.

A similar situation exists in fabrication and processing activities. Even in the case of centralized fabrication operated by some retailers there are limited opportunities to switch from one kind of meat to another. As with packers, retailers see reduced distribution costs as one major advantage of fabricating two or three kinds of meat at a central location. Unfortunately this is essentially an issue of economies of distribution which is outside the scope of this model. Much the same situation arises with the question of livestock assembly. No attempt will be made to determine optimum number and location of livestock assembly points with this model.

Since there is very limited potential for benefits from an integration of the two sectors into a single model a decision was taken to develop

two separate tableaus. The framework for the beef and pork sectors is very similar. Hence, for the sake of brevity the beef tableau is described in detail, while only differences that occur in the pork model are highlighted.

In its simplest form the objective can be stated as minimizing the aggregate cost of assembling cattle for slaughter, slaughtering cattle and fabricating carcasses into beef products, and distributing beef products to consumers. This objective must be achieved within certain constraints. Particularly in the case of cattle, the geographic distribution of livestock does not match that of consumers. The constraints therefore, involve meeting all the demand in each region with transportation and processing alternatives through which flow only the available supply of product in each region. The problem must be structured so that flows take place between points and it is therefore necessary to define a finite number of regions. The activities, constraints, and regions which apply to the two models are described briefly in the following paragraphs.

V.1 REGIONS

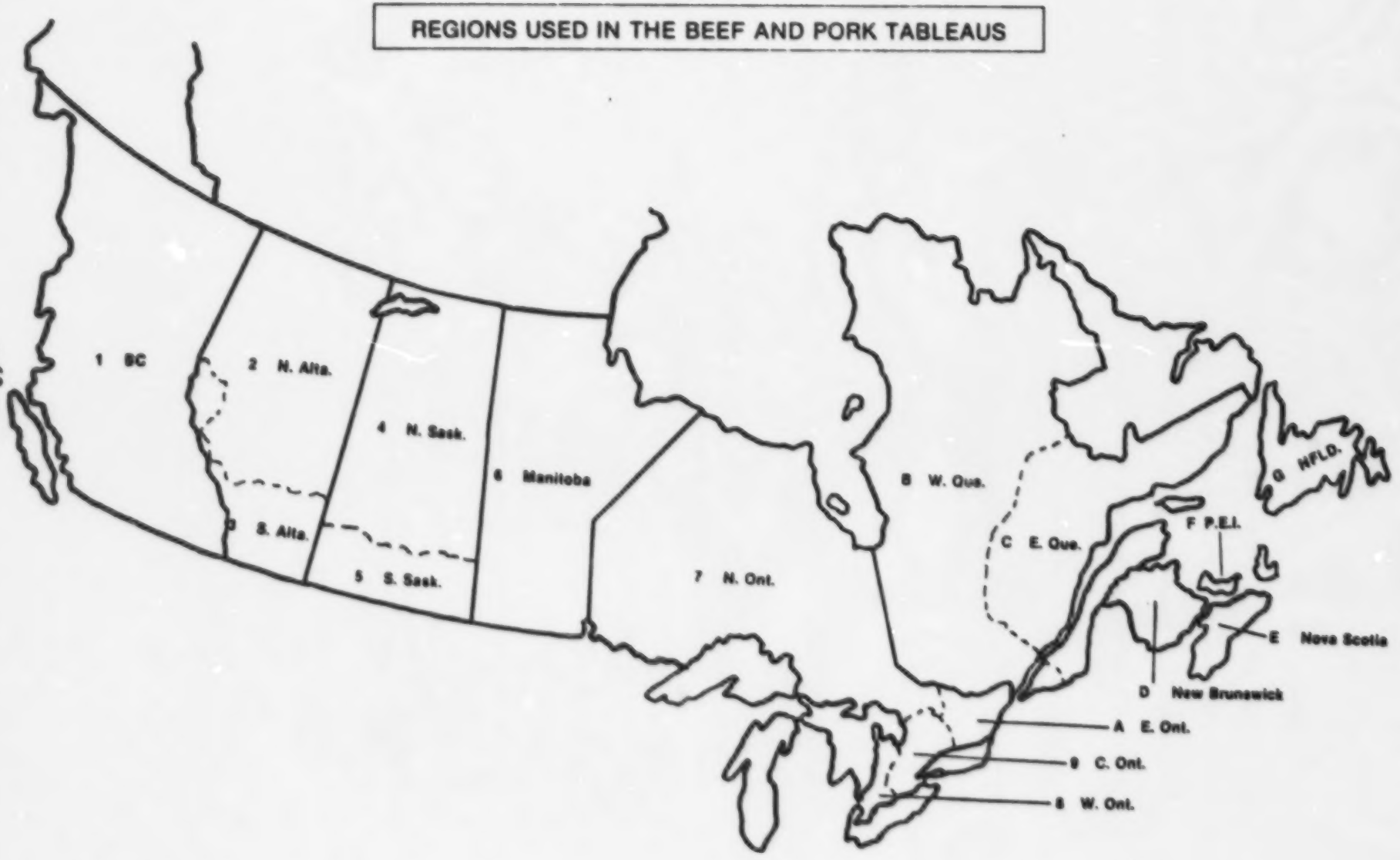
For purposes of this study Canada was divided into sixteen regions as shown in Figure V.1. The criteria for selection of regions incorporated the desire to have regions centered on major cities, relative uniformity in terms of livestock production, reasonable consistency with livestock marketing patterns, and maintenance of provincial boundaries. Livestock

marketing regions are based on crop reporting districts as defined in Agriculture Canada's reporting of livestock marketing statistics. The consumption regions are roughly the same but are based on 1981 Census divisions. Centres were chosen in each region for purposes of defining inter-regional shipping distances (road mileages).

TABLE V.1: REGIONS AND THEIR CORRESPONDING CITY CENTERS

Region	- - - City Centers - - - Livestock Supply	Population	Tableau Code
British Columbia	Kelowna	Vancouver	1
North Alberta	Edmonton	Edmonton	2
South Alberta	Calgary	Calgary	3
North Saskatchewan	Saskatoon	Saskatoon	4
South Saskatchewan	Regina	Regina	5
Manitoba	Winnipeg	Winnipeg	6
North Ontario	Sault Ste. Marie	Sault Ste. Marie	7
West Ontario	Chatham	Chatham	8
Central Ontario	Toronto	Toronto	9
East Ontario	Ottawa	Ottawa	A
West Quebec	Montreal	Montreal	B
East Quebec	Quebec City	Quebec City	C
New Brunswick	Moncton	Moncton	D
Nova Scotia	Halifax	Halifax	E
Prince Edward Island	Charlottetown	Charlottetown	F
Newfoundland	Gander	St. Johns	G
Exports (from Western Canada)	Los Angeles, Calif.	Los Angeles, Calif.	X
Exports (from Eastern Canada)	New York, N.Y.	New York, N.Y.	X
Exports to Japan		Japan	J
Imports	Omaha, Nebraska	Omaha, Nebraska	M

FIGURE V.1


REGIONS USED IN THE BEEF AND PORK TABLEAUS
1 BC
2 N. Alta.
3 S. Alta.
4 N. Sask.
5 S. Sask.
6 Manitoba
7 N. Ont.
8 W. Que.
C E. Que.
9 NFLD.
F P.E.I.
E Nova Scotia
D New Brunswick
A E. Ont.
B C. Ont.
B W. Ont.

V.2. THE BEEF TABLEAU

The beef tableau deals with:

a) Two primary products
   - fed cattle (heifers and steers)
   - non-fed cattle (cows and bulls)

b) Three intermediate products
   - carcass beef
   - boxed beef
   - boneless beef

c) Two final products
   - fresh beef cuts
   - ground beef

d) Eight processes
   - slaughter of fed cattle
   - slaughter of non-fed cattle
   - cutting carcasses to boxed beef
   - cutting carcasses to HRI cuts
   - cutting boxed beef to HRI cuts
   - cutting carcasses in retail stores
   - cutting boxed beef in retail stores
   - deboning

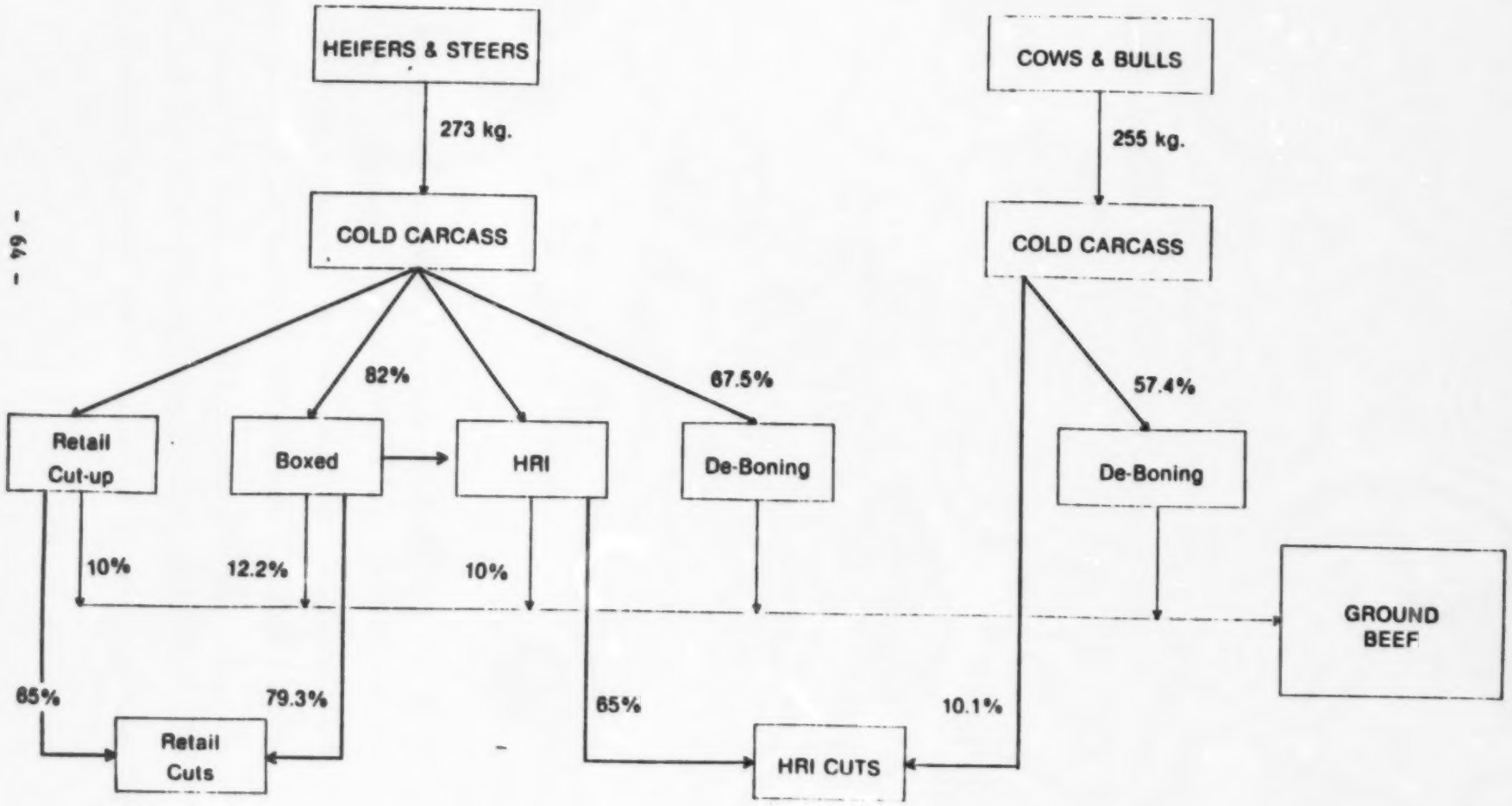
e) Inter-regional transportation of any product

The flow from primary to final product does not necessarily involve all of the intermediate products and processes. The alternatives are shown in Figure V.2.

Fresh beef cuts represent about 2/3 of beef consumed at home and come to the consumer through several possible channels. Cuts purchased at retail stores may have been cut from carcass or boxed beef in a retail store. The boxed beef received at retail may have been shipped from a central facility operated by the retail chain or from a packing plant. Final product delivered to HRI customers or to retailers as 'consumer-ready' cuts can be cut directly from carcasses either at the packing

FIGURE V.2

STRUCTURE OF CATTLE SLAUGHTER AND BEEF FABRICATION SYSTEM



plant or at a plant specializing in HRI cutting. Another alternative would be for the HRI specialist to cut from boxed beef.

For the most part, fresh retail or HRI cuts are obtained only from higher quality steer and heifer carcasses. But certain cuts (particularly the loin) from higher quality cow carcasses are suitable for use as fresh cuts. For this reason a portion of cow and bull carcasses is directed to satisfaction of the demand for fresh cuts.

Boneless beef is ultimately consumed in the form of ground beef and represents approximately one third of total beef consumption. It is a major factor in both the retail and HRI sectors. A number of avenues are open for the delivery of ground beef to the consumer. The trim by-product of beef cutting operations, whether carried out at cutting plants or in retail stores, is a major source representing approximately 10% of carcass weight. A second major source of ground beef is imports from Oceania. Imported boneless beef is very lean and is often mixed with domestic beef trimmings to achieve the desired fat to lean ratio. A third source of ground beef is the domestic slaughter of lower grade cattle. The bulk of cattle used for deboning are cows and bulls, but there are also limited numbers of heifers and steers grading B and C which are deboned. A fourth source is the diversion of top grade heifer and steer beef into ground beef. This option is implemented in the model by allowing 'fed' beef to enter the ground beef distribution system. The allocation of 'fed' beef between consumer-ready cuts and ground beef is, in fact, the only flexibility in the model allowing for the satisfaction of demand for both consumer-ready cuts and ground beef.

The identities which underlie the assembly, processing and distribution

activities of the model are very similar to those used in determining domestic disappearance of beef. Two departures from the domestic disappearance approach are worthy of note. First, only those cattle 'marketed at public stockyards, shipped directly to packing plants, and shipped directly from country points on export' are included here while disappearance statistics would include an allowance for uninspected slaughter. Second, no allowance has been made here for changes in storage stocks. Although a supply of beef from opening stocks and a demand for beef at ending stocks could be included in the tableau, this modification would add little to the analytical capability of the model and a decision was made not to include it.

Activities included in the model are summarized in Table V.2. The objective function ('C' in the tableau) contains cost coefficients for all the activities and evaluates to the minimum cost of assembly, processing and distributing beef in Canada.

Additional sets of constraints were imposed in the full tableau to take into account two important factors in the industry which are not otherwise dealt with, i.e. existing slaughter capacity in each region, and existing retail purchasing practices with regard to carcass, boxed, and consumer-ready beef. For the slaughter capacity constraint fed plus non-fed slaughter in each region is constrained to be less than or equal to the slaughter capacity in that region. Retail purchasing practices are implemented by constraining retail cutting of carcasses to specified minimum levels in each region. Retail cutting of boxed beef is also constrained to specified minimum levels in each region.

TABLE V.2: ACTIVITIES IN THE BEEF TABLEAU

ACTIVITIES	SYMBOLS	UNITS
Fed Sector		
- Assembly of Cattle	(F11---FM2)	Head
- Slaughter	(F1, F2)	Head
- Carcass Movement	(G11---GM2)	Carcass Wt
- Boxing	(B1, B2)	Carcass Wt
- Boxed Beef Movement	(B11---B22)	Boxed Wt
- Cutting Carcass to Consumer-Ready/ HRI In-plant	(H1, H2)	Carcass Wt
- Cutting Boxed Beef to Consumer-Ready/ HRI In-plant	(J1, J2)	Boxed Wt
- Consumer-Ready/HRI movement	(R11---R22)	Retail Wt
- Cutting Carcasses at Retail	(K1, K2)	Carcass Wt
- Cutting Boxed Beef at Retail	(L1, L2)	Boxed Wt
- Transfer of 'fed' carcass meat to 'boneless' distribution	(T1, T2)	Carcass Wt
Non-Fed Sector		
- Assembly of cattle	(N11---NM2)	Head
- Slaughter	(N1, N2)	Head
- Carcass Movement	(D11---D22)	Carcass Wt
- Deboning	(D1, D2)	Boneless Wt
- Movement, grinding, distribution of boneless beef	(H11---HM2)	Boneless Wt

V.3 THE PORK TABLEAU

The pork tableau deals with:

a) One primary product
   - live hogs

b) Two intermediate products
   - pork carcasses
   - pork primal cuts

c) Two final products

- fresh pork cuts
- processed pork products

d) Five processes
   - slaughter of live hogs
   - breaking carcasses into primal cuts
   - cutting primals to consumer-ready cuts
   - cutting primals in retail stores
   - preparation of processed pork products

e) Inter-regional transportation of any product

The flow from primary to final product shown in Figure V.3 is less complex than in the beef tableau. Hog carcasses are cut into primals with some trim going to the processing activity. Although some hog carcasses move in inter-packer trading, almost all movement to retail stores is in the form of primal cuts. The various primal cuts have different uses. Loins are the basis of most fresh retail pork cuts. Shoulders are used both for fresh cuts and for processing. Only a small portion of hams are sold fresh, and virtually all bellies are processed into side bacon.

Fresh pork cuts represent only about 35% of domestic pork disappearance. Although much of the preparation of fresh cuts from primals still takes place in retail stores, pork lends itself more to fabrication at central facilities. Unlike beef, pork can be cut and packaged for retail display at a central facility and distributed to stores without discolouration, odour, or other consequences unacceptable to the consumer. Although this approach is feasible, only a small weight reduction is achieved so that transportation costs are not significantly reduced. Relatively low labour requirements for cutting primals also reduce the labour efficiency advantage of central fabrication facilities.

Processed pork products represent about 65% of domestic pork disappearance. Processed products are most often produced at the packing plant but specialist processors also play an important role. In either case the final product will be packaged ready for retail display and will bear a brand name associated with the packer or specialist processor. Virtually no processing of pork products is carried out in retail stores.

The identities which underlie the assembly, processing and distribution activities of the model are very similar to those used to determine domestic disappearance except that marketings do not include an allowance for ungraded slaughter and no allowance is made for changes in storage stocks.

TABLE V.3: ACTIVITIES IN THE PORK TABLEAU

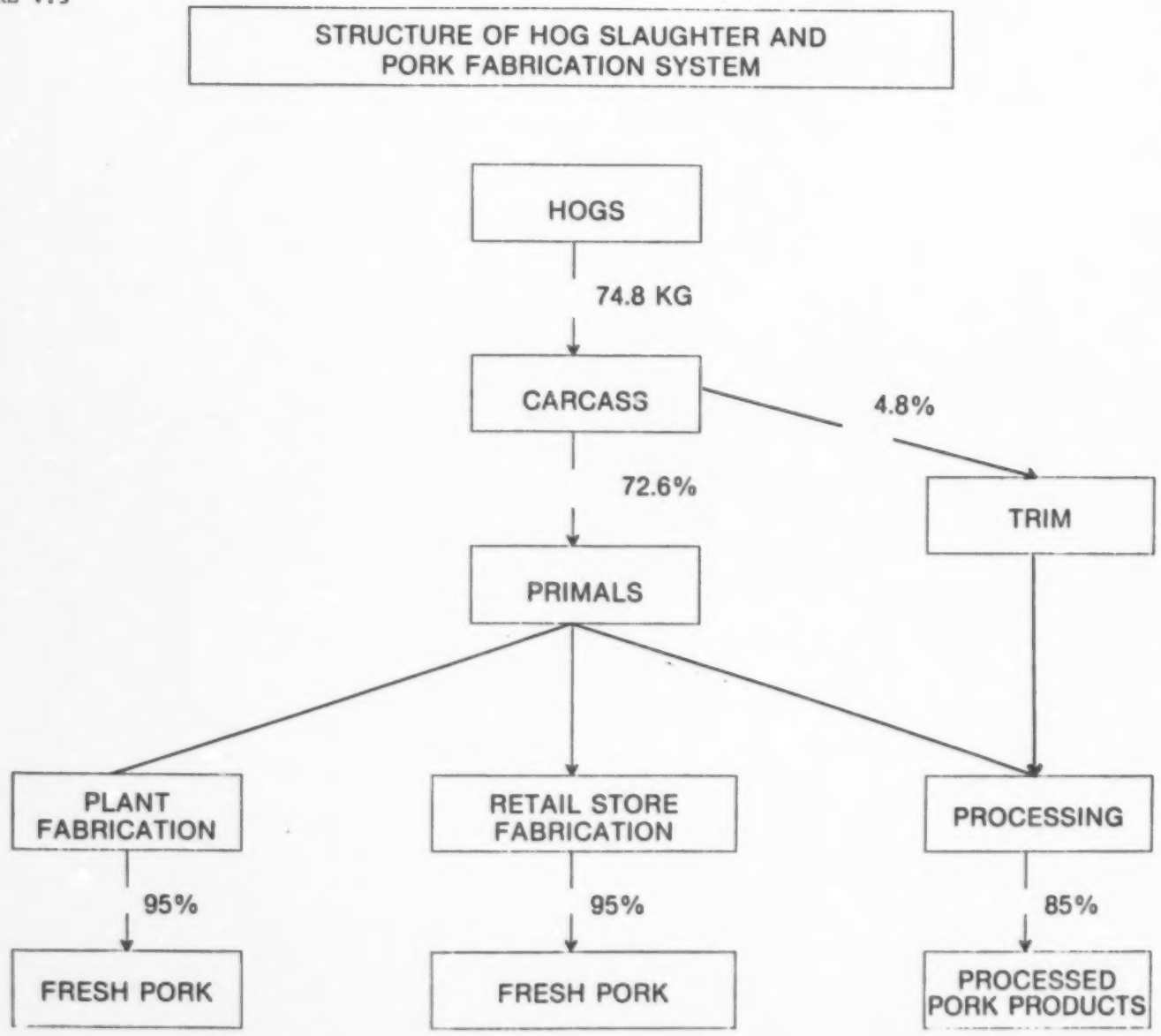
ACTIVITY	SYMBOL	UNITS
Assembly of Hogs	H11---H2X	Head
Slaughter	S1, S2	Head
Carcass Movement	S11---SM2	Untrimmed Carcass Wt
Cutting to Primals	B1, B2	Untrimmed Carcass Wt
Primal Movement	P11---PM2	Primal Wt
Fabrication to Retail cuts	F1, F2	Primal Wt
Retail Cuts Movement	R11---R2X	Retail Wt
Cutting at Retail stores	R1, R2	Primal Wt
Transfer Primals to Processing	X1, X2	Primal Wt
Pork-for-Processing Movement	T11---T22	Primal Wt
Pork Processing	P1, P2	Primal Wt
Processed Pork Movement	C11---CM2	Processed Wt

Activities included in the model are summarized in Table V.3.

The objective function ('C' in the tableau) contains cost coefficients for all of the activities and evaluates to the minimum cost of assembly, processing and distributing pork in Canada.

An additional set of constraints is implemented in the full tableau to limit slaughter to an upper bound equal to existing slaughter capacity in each region.

FIGURE V.3


STRUCTURE OF HOG SLAUGHTER AND PORK FABRICATION SYSTEM
HOGS
74.8 KG
CARCASS
4.8%
TRIM
72.6%
PRIMALS
PLANT FABRICATION
RETAIL STORE FABRICATION
PROCESSING
95%
95%
85%
FRESH PORK
FRESH PORK
PROCESSED PORK PRODUCTS

CHAPTER VI: VALIDATION

VI.1 VALIDATION RESULTS: BEEF

Validation procedures are applied to two major areas: the movement of live cattle, and the movement of meat. Detailed information on the movement of slaughter cattle is available from data published by Agriculture Canada. The forms in which beef moves and the flows which take place are less well defined. The survey of packers carried out as a part of this study produced detailed but incomplete data on meat movements that have proven useful in the validation process. There is also some useful information contained in special studies conducted by the Government of Quebec and the Alberta Cattle Commission.

The procedures available for measuring the model's performance are somewhat subjective. Indeed, it is the exception, rather than the rule, in the transportation models reviewed, to find a section devoted to the comparison of model results and the actual operation of the industry being modelled.

Actual and modelled inter-provincial movements of slaughter cattle are presented in Table VI.1. In several cases the annual data shows movement between two provinces in both directions. To improve clarity a separate column showing net movements has been included. The sub-provincial regions of the model have been aggregated to the provincial

level to facilitate comparisons. Similarly, fed and non-fed categories have also been combined.

The results reported here include the application of constraints related to slaughter capacities. The number of fed and non-fed cattle slaughtered in each region was constrained to the single shift capacity of slaughter plants operating in 1981. These constraints were limiting in all but four regions: South Alberta, Manitoba, Central Ontario and Newfoundland. Table VI.3 shows the constraints imposed in each region, levels of slaughter called for in the validation, capacity utilization and shadow prices generated by the model for regions where the constraints are limiting. Shadow prices of additional capacity are highest in East Quebec and in Nova Scotia. Excess capacity is highest in Manitoba.

With the constraints described above the model produces a reasonable approximation of reality. The actual net movement from British Columbia to Alberta of 1600 head is reversed in the validation, with the model calling for a movement of about four thousand head from Alberta to B.C. To the extent that British Columbia is a deficit region, this tendency to 'import' live cattle rather than 'export' them is not surprising. There are several possible explanations for the discrepancy: the estimate of slaughter capacity may be too high; the marketing infrastructure in Alberta may be more attractive to B.C. sellers; economies of scale in slaughtering may make larger Alberta packers competitive with smaller B.C packers; or, B.C. packers may wish to preserve a situation in which they buy live cattle on an 'export' basis

TABLE VI.1: - INTERPROVINCIAL MOVEMENT OF SLAUGHTER CATTLE, ACTUAL 1981 VS VALIDATION SOLUTION

Source	Destination	Actual	Actual Net	Model
B.C. to	B.C.	71.3		74.7
	Alberta	3.4	1.6	
Alberta to	B.C.	1.8		4.1
	Alberta	1297.6		1321.9
	Saskatchewan	13.5		
	Manitoba	6.3	6.3	
	Ontario	6.9	6.9	
Sask. to	Alberta	14.7	1.1	
	Saskatchewan	203.7		205.7
	Manitoba	64.8	64.7	30.7
	Ontario	3.7	3.7	
	Quebec	0.1	0.1	
Manitoba to	Alberta	---		
	Saskatchewan	0.1		
	Manitoba	242.5		247.0
	Ontario	9.4	8.3	
	Quebec	0.4	0.4	
Ontario to	Manitoba	1.1		
	Ontario	878.8		837.4
	Quebec	59.2	54.9	68.9
	Maritimes	3.3	3.3	
Quebec to	Ontario	4.3		
	Quebec	200.9		193.4
	Maritimes			11.8
Maritimes to	Quebec	1.1	1.1	
	Maritimes	46.0		47.1

and sell their finished products at 'import' basis prices.

Movements of live cattle from Alberta to Manitoba and to Ontario do not appear in the model but these actual movements represent less than 1% of Alberta marketings. The model underestimates the actual movement of live cattle from Saskatchewan into Manitoba even with the capacity constraint in place. This may be caused by an overestimate of slaughter capacity in Saskatchewan. The actual movement of cattle from Saskatchewan for slaughter in Manitoba represents almost one quarter of marketings in Saskatchewan. It is also interesting to note, in the 1981 actual data, a significant exchange of cattle for slaughter between Saskatchewan and Alberta with the net result being a very small net movement from Saskatchewan to Alberta. Neither the swapping nor the net movement from Saskatchewan to Alberta appears in the validation. Modelled Manitoba movements correspond closely with reality, again with the exception of minor movements toward Eastern Canada.

The Ontario situation in the validation differs from the actual in two respects. First, minor "actual" movements from Western Canada are not present in the validation. Second, the small movement from Ontario into the Maritime provinces, which, according to the industry, is a result of efforts by the Maritime plants to maintain a steady supply of cattle for slaughter, is not present in the validation. There is, however, a movement from Quebec into the Maritimes in the validation.

Modelled import/export movements differ in some respects from actual movements (see Table VI.2). Net imports of fed cattle were evident in Western Canada in 1981 but were not an important proportion of total slaughter in any province. These small net imports of fed cattle into

TABLE VI.2: INTERNATIONAL TRADE IN LIVE CATTLE FOR SLAUGHTER, ACTUAL 1981 VS VALIDATION SOLUTION

		ACTUAL				MODEL	
		Fed		Non-Fed			
Source	Destination	Gross	Net	Gross	Net	Fed	Non-Fed
Exports to	Alberta	0.8	0	0	0	0	0
	Saskatchewan	1.6	1.3	0	0	0	0
	Manitoba	5.8	2.7	-	0	0	0
	Ontario	144.1	142.0	0.6	0	152.3	0.7
	Quebec	0	0	-	0	0	0
	Maritimes	0	0	-	0	0	0
Imports from	B.C.	3.7	3.7	20.0	20.0	0	0
	Alberta	5.1	4.3	9.7	9.7	0	0
	Saskatchewan	0.3	0	9.0	9.0	15.7	34.6
	Manitoba	3.1	0	19.6	19.6	0	4.3
	Ontario	2.1	0	15.6	15.0	0	27.7
	Quebec	0	0	2.4	2.4	0	0
	Maritimes	1.0	1.0	1.5	1.5	0	0

0 = none

- = less than 500

TABLE VI.3: CATTLE SLAUGHTER CAPACITY CONSTRAINTS

Region	Slaughter - Upper Limit (000 hd)	Slaughter - Validation (000 hd)	Capacity Utilization (%)	Shadow Price ($/hd)
B. C.	78.75	78.75	100	5.50
N. Alberta	315.00	315.00	100	10.53
S. Alberta	1177.50	1006.93	85	-
N. Sask.	78.75	78.75	100	11.14
S. Sask.	127.00	127.00	100	4.66
Manitoba	572.50	277.69	48	-
N. Ontario	12.00	12.00	100	8.97
W. Ontario	107.50	107.50	100	5.33
C. Ontario	1220.50	828.37	68	-
E. Ontario	42.50	42.50	100	14.39
W. Quebec	218.75	218.75	100	8.75
E. Quebec	43.50	43.50	100	19.33
N. B.	37.50	37.50	100	7.63
N. S.	11.25	11.25	100	18.31
P.E.I	10.00	10.00	100	16.23
NFLD	.30	.18	59	-

Western Canada are not present in the validation. On the export side, the model has a tendency to export all cattle in the fed category from Saskatchewan. The distribution of exports between Eastern and Western Canada in the validation is reasonably close to actual movements even though exports by province do not validate well. Cow and bull exports from Eastern Canada in the model are somewhat higher than actual movements with a corresponding underestimate of exports from Western Canada. The emphasis on exports from Saskatchewan in the validation is due to the combination of a surplus position with regard to live cattle and the slaughter capacity constraint.

Comparison of actual and validation carcass beef movement reveals that

in both cases beef movement is almost exclusively West to East. An exception in both the model and the survey results is movement from South Alberta into B.C. In both cases, the distribution of carcasses from Alberta covers a fairly wide spectrum of eastern destinations. The model does not, however, have the volume and concentration of carcasses into the Montreal market which is evident in the survey results. The distribution of carcasses from Central Ontario is more widespread (from Central Ontario to other Ontario regions and the Maritimes) in the survey than in the model results. The extent of carcass movement from Ontario into Quebec is close to that reported in the survey results.

VI.2 VALIDATION RESULTS: PORK

Validation procedures are applied to two major areas: the movement of live hogs, and the movement of pork products. Detailed information on the movement of hogs is available from data published by Agriculture Canada. The forms in which pork moves and the volumes involved are less well defined. The survey of packers carried out as a part of this study produced detailed but incomplete data on meat movements which have proven useful in the validation process.

Actual and validation inter-provincial movements of hogs for slaughter are presented in Table VI.4. In several cases the annual data shows movement between two provinces in both directions. To improve clarity a separate column showing net movements has been included. The sub-provincial regions of the model have been aggregated to the provincial level to facilitate comparison.

The results reported here include slaughter capacity constraints in each region which limit hog slaughter to the single shift capacity of slaughter plants operating in 1981. The constraints were limiting in several regions: Saskatchewan; North, West, and East Ontario; East Quebec; and all of the Atlantic provinces. Table VI.5 shows the constraints imposed in each region, levels of slaughter called for in the validation, capacity utilization, and shadow prices generated by the model for regions where the constraints are limiting.

Shadow prices of additional capacity are highest in Newfoundland and in

TABLE VI.4 INTERPROVINCIAL MOVEMENT OF SLAUGHTER HOGS, ACTUAL 1981 VS VALIDATION SOLUTION

Source	Destination	Actual	Actual Net	Model
			- - - 000 head - - - -	
B.C. to	B.C.	328.9		339.0
	Alberta	9.7	5.6	
Alberta to	B.C.	4.1		
	Alberta	1566.6		1601.3
	Saskatchewan	10.0		
Saskatchewan to	Alberta	131.5	121.5	12.4
	Saskatchewan	522.3		655.0
	Manitoba	0.2		
	Ontario	0.1		
Manitoba to	Saskatchewan	2.0	1.8	
	Manitoba	1145.8		1219.6
	Ontario	18.1	18.1	
	Quebec	0.8	0.8	
Ontario to	Ontario	3870.7		3810.1
	Quebec	189.4	187.5	160.5
Quebec to	Ontario	1.9		
	Quebec	4733.6		4737.6
Atlantic to	Quebec	11.6	11.6	19.0
	Atlantic	498.3		491.3

EXPORT MOVEMENT - LIVE HOGS	Actual	Model
B.C.	.4	
Alberta	20.5	
Saskatchewan	13.3	
Manitoba	52.8	
Ontario	17.5	107.0
Quebec	2.1	
Atlantic	0.3	

TABLE TABLE VI.5: HOG SLAUGHTER CAPACITY CONSTRAINTS

Region	Slaughter Upper Limit (000 head)	Slaughter Validation (000 head)	Capacity Utilization (%)	Shadow Price ($/head)
B. C.	431.0	339.0	79	-
N. Alberta	1400.0	1042.3	74	-
S. Alberta	650.0	571.4	88	-
N. Sask.	390.0	390.0	100	3.32
S. Sask.	265.0	265.0	100	.51
Manitoba	1475.0	1219.6	83	-
W. Ontario	5.0	5.0	100	4.03
C. Ontario	4040.0	3805.1	94	-
W. Quebec	4160.0	3647.1	88	-
E. Quebec	1270.0	1270.0	100	3.43
N. B.	137.5	137.5	100	12.50
N. S.	178.8	178.8	100	16.21
P. E. I.	145.0	145.0	100	13.61
NFLD	30.0	30.0	100	26.63

Nova Scotia. Shadow prices in all of the Atlantic provinces exceed the cost of slaughter ($11.75/hd) indicating that live hogs are being 'exported' and pork products 'reimported' for consumption. Capacity utilization is lowest in the North Alberta region.

With the constraints described above the model produces a reasonable approximation of reality. There is, however, no movement from Alberta to B.C. in the validation comparable to an actual net movement of 5.6 thousand head. In Saskatchewan a movement into Alberta of 12.4 thousand head in the validation compares to an actual net movement of 121.5 thousand head. Actual small movements out of Manitoba (less than 2% of marketings in all cases) do not appear in the validation. The movement of 160.5 thousand head from Ontario into Quebec in the model compares

favourably with an actual net movement of 187.5 thousand head. The model accurately simulates a minor movement (less than 3% of marketings) from the Maritime provinces into Quebec. Export movements do not validate well, with exports in the validation originating in the West Ontario region as opposed to actual exports from a number of provinces, including substantial exports of hogs from Western Canada.

CHAPTER VII: EXPERIMENTS

The purpose of this chapter is to report the results of several analyses performed using the model. The experiments conducted are as follows:

1) Impact of projected changes in livestock production and foreign trade in live animals and meat for 1986. The analysis is based on projections prepared by the Livestock Unit, Marketing and Economics Branch of Agriculture Canada.

2) Impact of projected changes in livestock production and foreign trade in live animals and meat five years subsequent to the implementation of a 'pay the railroads' alternative to the Crow's Nest Statutory freight rates for grain. The analysis is based on impacts estimated by David Harvey in 'an Economic Analysis for the Crow Rates' [15].

3) Impact of major changes in retail purchasing behaviour for beef resulting in an increase in boxed beef penetration from the current 45% to 75%.

4) Analysis of effects of economies of scale on the optimum size and location of slaughter plants.

5) Impact of reduced cattle and hog slaughter capacities in Prince Edward Island due to the announced closing of the Canada Packers plant there.

6) Impact of increased cattle and hog slaughter capacity in eastern Quebec and Nova Scotia respectively. The sites for increased capacity were chosen on the basis of high economic rents associated with existing slaughter capacity in these regions.

For each experiment the assumptions underlying the analysis are reviewed and the results presented in relation to a suitable benchmark, usually the validation.

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For each experiment the assumptions underlying the analysis are reviewed and the results presented in relation to a suitable benchmark, usually the validation.

VII.1 PROJECTED 1986 LIVESTOCK PRODUCTION AND TRADE ('BASE 1986')

The analysis is based on projections of livestock production and foreign trade prepared by the Marketing and Economics Branch of Agriculture Canada, estimates of changes in real transportation and processing costs, and increased boxed beef penetration. The main features of these projections are:

- An 11% increase in live cattle exports and a 49% decrease in imports. 1981 cattle imports were higher than normal.
- Beef exports decline by 3% and imports increase by 8%.
- Cattle slaughter increases in Western Canada but falls in Eastern Canada resulting in a net decrease of 3% for Canada.
- Imports of pork decrease by 20% while exports of pork increase by 35% and of live hogs by 94%.
- Hog slaughter is expected to increase by 6% in both Eastern and Western Canada.
- The real cost of slaughter and processing activity is expected to increase by .95 % and the real cost of transportation by 1.23%.
- Boxed beef penetration in the retail sector is expected to increase by 5% in Western Canada, and by 10% in Eastern Canada.

The net effect, including change in population, is a slightly reduced per capita consumption of beef and a slightly increased per capita consumption of pork.

The population projections used for this experiment reflect preliminary estimates prepared by Statistics Canada on the basis of the 1981 census.

VII.1.1 BEEF

Important differences from the 1981 validation are:

- Live cattle marketings are only slightly (less than 1%) below 1981.
- Live cattle imports (both fed and non-fed) are reduced by 49%.
- The result of changes in marketings and trade is live cattle slaughter 3% below 1981.
- Imports of both fresh and boneless beef are 8% above 1981.
- Exports of both fresh and boneless beef are 3% below 1981.
- Average carcass weight increases 1% for both fed and non-fed slaughter.

The Agriculture Canada projections for Eastern and Western Canada were not applied evenly to each province in their respective regions. The provincial variances from regional projections are based on trends evident in cattle marketings over the ten years from 1972 to 1981. Changes in marketings by region are shown in Table VII.1.1.

Capacity constraints were not changed from 1981 levels. Regional disappearance reflects slightly reduced disappearance, and population shifts embodied in the 1986 population estimates.

Highlights of the results are as follows:

- Increased marketings in Quebec did not create a slaughter capacity problem because movement of live cattle from West Ontario was lower, freeing up slaughter capacity in Quebec.
- Excess capacity in Alberta decreased due to increased

TABLE VII.1.1: BASE 1986 REGIONAL DISTRIBUTION OF CATTLE MARKETINGS

Region(s)	-- Percentage Change in Marketings -- Fed Cattle	Non-Fed Cattle
British Columbia	+45	- 3
Alberta	+ 1	0
Saskatchewan	0	+ 2
Manitoba	0	- 6
Ontario	- 9	0
Quebec	+60	0
New Brunswick	- 1	0
Nova Scotia	- 9	-16
Prince Edward Island	- 9	0
Newfoundland	- 9	0

Alberta marketings and movement of non-fed cattle from B.C. into Alberta for slaughter.

- Excess capacity in Manitoba increases (due to reduced marketings) and in Ontario (due to reduced imports of live cattle and reduced marketings in Western and Central Ontario).

- Carcass movement from Ontario to Quebec decreases. In the 1981 validation imported cattle supplied the Quebec market through slaughter in Ontario and carcasss movement from Ontario into Quebec. The drop in imports, then, can be directly linked to the drop in carcass movement from Ontario to Quebec.

- Carcass and boxed beef movement from Alberta to Quebec increases. Alberta carcass and boxed beef essentially replaces Ontario carcass beef in the Quebec market.

- Boxing activity increases in Alberta and Central Ontario

- Slaughter in B.C. is exclusively fed cattle. Non-fed cattle marketed in B.C. go to Alberta for slaughter.

- Ground beef movement from Alberta to B.C. increases. Thus B.C. sends out cows and brings in ground beef to meet demand.

The tendency to slaughter fed rather than non-fed cattle in a region

where slaughter capacity is a constraint appears many times in this and other experiments. This tendency is due to the larger weight reduction in deboning in comparison to carcass or boxed beef and the resulting transportation cost advantage of boneless movement. More precisely, when forced to move 1000 lbs of live animal out of a region the model will move non-fed cattle and bring back 390 lbs of boneless beef rather than move fed cattle and bring back 490 to 600 lbs of boxed or carcass beef.

Table VII.1.2 summarizes capacity utilization where excess capacity

TABLE VII.1.2: CAPACITY UTILIZATION AND SHADOW PRICES FOR CATTLE SLAUGHTER CONSTRAINTS

	- Capacity Utilization -		-- Shadow Price --	
Region	Validation %	Base 1986 %	Validation $/head	Base 1986 $/head
British Columbia			5.85	35.00
North Alberta			10.41	10.42
South Alberta	86	89		
North Sask.			10.82	10.73
South Sask.			4.42	4.35
Manitoba	49	47		
North Ontario			8.86	8.94
West Ontario			10.20	5.38
Central Ontario	68	58		
East Ontario			14.12	14.30
West Quebec			8.48	8.68
East Quebec			19.19	19.41
New Brunswick			7.64	7.94
Nova Scotia			18.41	7.85
P. E. I.			15.72	16.04
Newfoundland	59	57		

exists and shadow prices where capacity is fully utilized.

Noteworthy features are the extremely high shadow value on slaughter capacity in B.C. (due to increased marketings), and significant declines in capacity utilization in Manitoba and Ontario. Although there are increased marketings in Quebec there are only small changes in the shadow value. Whereas the constraint in B.C. necessitates shipment of cattle out of the province and shipment of meat back in to meet demand, increased Quebec marketings merely replace live cattle movement from West Ontario.

VII.1.2 PORK

Important differences from the 1981 validation are:

- Live hog marketings are 7% above 1981.
- Live hog exports are almost double those in 1981.
- Hog slaughter is 6% higher.
- Carcass, primal (fresh), and processed imports are 20% lower.
- Carcass exports are 50% higher than in 1981.
- Primal exports to the U.S.A. are 46% higher.
- Primal exports to Japan are 14% higher.
- Processed exports are 25% higher.

The Agriculture Canada projections of 1986 hog marketings for Eastern and Western Canada were not applied evenly to each province in the respective regions. The differences shown for each region are based on trends evident in hog marketings over the ten years from 1972 to 1981. Changes in marketings by region were implemented as follows:

Region(s)	BC	Alta	Sask	Man	Ont	Que	N.B.	N.S.	PEI	NFLD
% Change in Marketings	+55	+3	+1	+3	+5	+9	+8	+5	0	0

Capacity constraints were not changed from 1981 levels. Regional disappearance reflects slightly higher total supply (+ 2%) and population shifts embodied in the 1986 population estimates.

Highlights of the results are as follows:

- Increased movement of live hogs from B.C. to North and South Alberta regions for slaughter.
- Increased movement of live hogs from the Atlantic provinces into Quebec for slaughter.
- Increased exports of pork primals originate in Ontario and Quebec.
- Movement of consumer-ready cuts from Alberta to B.C. decreases while the movement of processed products from Alberta to B.C. increases. In a region where slaughter capacity is constraining there is a tendency to use local slaughter for fresh trade and ship in processed products. Processed products have a lower yield than fresh and are therefore less costly to transport.
- Movement of consumer-ready cuts from Central Ontario to the West Ontario region increases due to a decrease in imports of primals into that region.

Table VII.1.3. summarizes capacity utilization where excess capacity exists, and shadow prices where capacity is fully utilized.

Noteworthy features are the high shadow price on slaughter capacity in B.C. (due to marketings increasing to exceed slaughter capacity), and increases in capacity utilization generally reflecting an overall increase in marketings. Capacity utilization in South Alberta reaches

TABLE VII.1.3: BASE 1986 CAPACITY UTILIZATION AND SHADOW PRICES FOR HOG SLAUGHTER CONSTRAINTS

Region	- Capacity Utilization - Validation %	Base 1986 %	----- Shadow Price ------ Validation $/head	Base 1986 $/head
B. C.	79			13.10
North Alberta	74	79		
South Alberta	88			2.82
North Sask.			3.32	3.34
North Sask.			.51	.48
Manitoba	83	85		
West Ontario			4.03	4.11
Central Ontario	94	96		
West Quebec	88	99		
East Quebec			3.43	2.64
New Brunswick			12.50	11.88
Nova Scotia			16.22	15.66
P. E. I.			13.61	12.99
Newfoundland			26.63	26.27

100% and a small shadow price is generated.

VII.2 IMPLEMENTATION OF 'PAY THE RAILWAYS' REVISION OF CROW RATE

The analysis is based on estimated impacts on regional livestock marketings five years subsequent to the implementation of a 'Pay the Railways' Revision of the Crow Rate. The estimates used are those prepared by David Harvey [15]. To simplify the analysis it is assumed that the rate revision was implemented in 1981. Therefore the effects by 1986 were analyzed. The main features of Harvey's impact estimates

are an increase of 1.8% in heifer and steer slaughter in Western Canada, an increase of 4.9% in hog slaughter in Western Canada, and no change in either cattle or hog slaughter in Eastern Canada.

VII.2.1 BEEF

Important differences from the 1981 validation are:

- Fed cattle marketings increase by 1.2% (1.8% in Western Canada, no change in Eastern Canada).
- Non-fed cattle marketings do not change.
- 1986 imports of live cattle decrease about 20% from 1981 levels.
- Cattle slaughter remains virtually unchanged.
- Imports and exports of carcass and boneless beef remain unchanged.
- Disappearance of beef remains unchanged.

Dealing with the increased marketings implied in David Harvey's work involved assuming no change in disappearance and adjusting the import/export variables in a manner consistent with trends in those variables so as to achieve the appropriate balance between supply and disappearance in the domestic market.

The regional distribution of livestock marketings reflects the increased fed (+1.8%) marketings called for in Western Canada. Although the cattle feeding sector in B.C. has not been important in the past, recent rapid increases in fed cattle marketings in that province indicate that

B.C. would probably share fully in increased Western marketings. Slaughter capacity in each region is unchanged from 1981 levels. Carcass and boxed beef maintain the same retail penetration as in 1981.

Highlights of the results are as follows:

- Slaughter capacity utilization increases marginally in Western Canada and declines in Central Ontario.
- Slaughter of fed cattle increases in South Alberta and Manitoba.
- Carcass movement from South Alberta to Quebec increases, replacing movement from Central Ontario to Quebec.
- Several minor changes occur in carcass movements from the West to markets in Eastern Canada.
- There are no changes in the remaining activities: boxing, cutting to consumer-ready, non-fed slaughter, or deboning.

Table VII.2.1 summarizes capacity utilization where excess capacity exists and shadow prices where capacity is fully utilized.
The only noteworthy features are slightly improved capacity utilization in Western Canada and reduced capacity utilization in Central Ontario (due to the decline in cattle imported for slaughter).

VII.2.2 PORK

Important differences from the 1981 validation are:

- Live hog marketings increase by 1.4% (4.9% in Western Canada, unchanged in Eastern Canada).
- Exports of live hogs increase about 20% (107 to 131

TABLE VII.2.1: CROW CHANGE IMPACT ON CAPACITY UTILIZATION AND SHADOW PRICES FOR CATTLE SLAUGHTER

Region	- Capacity Utilization - Validation %	Crow Change %	----- Shadow Price ---- Validation $/head	Crow Change $/head
B. C.			5.50	5.54
North Alberta			10.53	10.43
South Alberta	86	87		
North Sask.			11.14	11.13
South Sask.			4.66	4.65
Manitoba	49	50		
North Ontario			8.97	8.87
West Ontario			5.33	5.33
Central Ontario	68	65		
East Ontario			14.39	14.29
West Quebec			8.75	8.75
East Quebec			19.33	19.33
New Brunswick			7.63	7.53
Nova Scotia			18.31	18.21
P. E. I.			16.23	16.13
Newfoundland	59	59		

thousand head).

- Hog slaughter increases 1.3%.
- Carcass pork imports and exports remain unchanged.
- Imports of pork primals remain unchanged. Exports to the U.S. remain unchanged but exports to Japan increase about 20%.
- Imports and exports of processed pork products remain unchanged.
- Total disappearance of pork products remains unchanged. The hog pricing structure was on an export basis in 1981 and would not change under the new circumstances.

The impact of Crow Rate revisions on the Canadian pork market is rather small. The extra production from Western Canada can be absorbed through

moderate increases in exports. The regional distribution of hog marketings reflects recent trends in provincial hog marketings. B.C. marketings increase faster than average (+8.5%), Saskatchewan marketings slower than average (+3.1%) and Alberta and Manitoba marketings increase at the average of 4.9% for Western Canada. Slaughter capacity constraints in the various regions remain the same as in the validation (1981).

Highlights of the results are as follows:

- Slaughter capacity utilization increases in Western Canada.
- Additional live hog exports to the U.S. are shipped from Ontario.
- Ontario, and to a lesser extent, Manitoba fill the additional requirements for exports of primals to Japan.
- Processing activity increases in B.C., North Alberta and Manitoba but decreases in Central Ontario.
- Manitoba, rather than Central Ontario supplies North Ontario with processed pork products.
- North Alberta replaces Manitoba as supplier of processed pork products in the B. C. market.
- The production, processing and distribution patterns in Quebec and the Atlantic provinces are virtually unchanged.

Table VII.2.2 summarizes capacity utilization where excess capacity exists, and shadow prices where capacity is fully utilized.
The only changes are increases in capacity utilization in Western Canada.

TABLE VII.2.2: CROW CHANGE IMPACT ON CAPACITY UTILIZATION AND SHADOW PRICES FOR HOG SLAUGHTER

Region	Capacity Utilization		----- Shadow Price -----	
	Validation %	Crow Change %	Validation $/head	Crow Change $/head
B. C.	79	85		
North Alberta	74	80		
South Alberta	88	92		
North Sask.			3.32	3.32
South Sask.			.51	.51
Manitoba	83	87		
West Ontario			4.11	4.11
Central Ontario	94	94		
West Quebec	88	88		
East Quebec			3.43	3.43
New Brunswick			12.50	12.50
Nova Scotia			16.22	16.22
Prince Edward Island			13.61	13.61
Newfoundland			26.63	26.63

VII.3 INCREASED BOXED BEEF PENETRATION IN THE RETAIL STORE MARKET

This experiment attempts to analyse the effect of increased boxed beef penetration in the retail store market. In the validation, shipments of carcass, boxed and consumer-ready cuts are constrained so that they cannot exceed estimates of market penetration for 1981. In this experiment the market penetration of boxed beef is increased substantially and that of carcass beef reduced accordingly. All other aspects of cattle production, livestock and meat trade, and beef disappearance remain the same as in the validation. Slaughter capacity constraints, regional distribution of livestock marketings and regional

distribution of beef consumption are also identical to those in the validation. Only retail cutting constraints differ from the validation .

The changes implemented in this experiment have far reaching consequences for the industry. The highlights are as follows:

- Exports of fed cattle from North Saskatchewan cease and export demand for live cattle is satisfied from West Ontario instead. The fed cattle marketed in North Saskatchewan are slaughtered there (and in Manitoba) instead of being exported.

- West Ontario live cattle are slaughtered in Ontario (fewer go to Quebec). Fed cattle no longer move from East Quebec into New Brunswick and are slaughtered in Quebec. Non-fed cattle move from Quebec to New Brunswick for slaughter instead.

- Slaughter of fed cattle declines in West Quebec, New Brunswick and Prince Edward Island and increases in east Quebec reflecting rationalization of slaughter activity in Quebec and the Atlantic provinces.

- Several carcass movements are reduced reflecting the lower minimum constraints on carcass purchases at retail. These include:

  - Alberta to East Ontario and Quebec
  - Alberta to British Columbia
  - Saskatchewan to Newfoundland
  - Manitoba to North Ontario and the Maritimes
  - Central Ontario to East Quebec

- Boxing activity increases but only minor changes take place in the location of this activity. Alberta, Saskatchewan, Manitoba and West and Central Ontario remain the only regions with significant levels of boxing activity. A small boxing activity in Prince Edward Island is the only new boxing activity in this experiment.

- Movements of boxed beef increase or new movements are called for in several instances:

  - N. Alberta to E. Ontario
  - N. Alberta to Newfoundland
  - S. Alberta to B.C.
  - S. Alberta to W. Quebec

  - S. Saskatchewan to E. Quebec
  - Central Ontario to Quebec

- Boxed beef movement from North Alberta to the Maritime provinces decreases and is replaced by boxed beef movement from Manitoba.

- Carcass cutting at retail is down and boxed cutting up reflecting the changes in constraints which allow more retail cutting from boxed beef.

- Non-fed cattle marketed in East Ontario are slaughtered in Quebec rather than Central Ontario. This is a consequence of discontinued movement of West Ontario fed cattle into Quebec for slaughter.

- Exports of non-fed cattle from Manitoba cease and are replaced from Saskatchewan marketings.

- Non-fed cattle move from P.E.I. to Nova Scotia instead of New Brunswick for slaughter.

- Non-fed slaughter decreases in Saskatchewan, Central Ontario and Quebec; but increases in Manitoba, New Brunswick and P.E.I.

- Deboning activity increases in Manitoba, West Quebec, and Prince Edward Island.

- Boneless beef imports to Central Ontario, West Quebec, New Brunswick, and Prince Edward Island are reduced but increase in East Quebec and North Ontario.

Table VII.3.1 summarizes capacity utilization where excess capacity exists, and shadow prices, where capacity is fully utilized. There are only minor changes from the validation. Shadow prices in Saskatchewan are slightly higher, whereas those in the Maritime provinces are slightly lower.

The shadow prices on the carcass cutting constraint are also of interest in this experiment. They are compared to Validation in Table VII.3.2 and are significantly lower in all regions except B.C.

TABLE VII.3.1: INCREASED BOXING IMPACT ON CAPACITY UTILIZATION AND SHADOW PRICES FOR CATTLE SLAUGHTER

Region	-- Capacity Utilization -- Validation %	More Boxed %	-- Shadow Price -- Validation $/head	More Boxed $/head
B. C.			5.50	5.50
North Alberta			10.53	10.27
South Alberta	86	86		
North Sask.			11.14	12.71
South Sask.			4.66	5.82
Manitoba	49	51		
North Ontario			8.97	12.58
West Ontario			5.33	6.03
Central Ontario	68	67		
East Ontario			14.39	14.69
West Quebec			8.75	8.75
East Quebec			19.33	19.33
New Brunswick			7.63	4.47
Nova Scotia			18.31	15.14
P. E. I.			16.23	12.49
Newfoundland	59			1.20

VII.4 ECONOMIES OF SCALE IN SLAUGHTERING

This experiment attempts to analyse the effect of economies of scale on the size and location of slaughter facilities. Economies of scale were developed from the financial modelling studies developed as a part of this study. All livestock marketing and trade, meat trade, and disappearance parameters (including regional distributions) are exactly the same as those used in the validation. The technique used to

TABLE VII.3.2: INCREASED BOXING IMPACT ON SHADOW PRICE OF CARCASS CUTTING CONSTRAINT

Region	--- Shadow Price ($/tonne carcass wt) -- Validation	More Boxed Experiment
British Columbia	23.98	23.98
North Ontario	41.26	31.69
East Ontario	50.18	29.80
West Quebec	52.50	30.17
East Quebec	54.18	31.84
New Brunswick	61.24	20.61
Nova Scotia	64.38	49.59
Prince Edward Island	62.92	19.97
Newfoundland	77.13	62.74

evaluate the effects of economies of scale is similar to the iterative technique developed by King and Logan [18]. The procedure can be summarized as follows:

1) Remove the slaughter capacity constraints from the validation and find an optimum solution without capacity constraints.

2) Examine the unconstrained solution and substitute slaughter costs consistent with slaughter activity in each region. Since slaughter costs in all regions are initially set to the costs attributable to the smallest scale plant, the adjustments consist of substituting lower cost coefficients attributed to larger plants according to the level of slaughter in each region.

3) Find an optimum solution with adjusted cost coefficients.

4) Repeat steps (2) and (3) until cost/throughput relationships in each region are consistent after solution.

In the case of both the beef and pork sectors, the appropriate solution was achieved after only one iteration.

VII.4.1 BEEF

Economies of scale in cattle slaughter are reviewed in Table VII.4.1. Results of the experiment are presented in two parts: the initial unconstrained solution (with comparison to validation), and the final solution which is compared to both the initial and validation solutions.

TABLE VII.4.1: SUMMARY OF ECONOMIES OF SCALE ANALYSIS FOR CATTLE SLAUGHTER

	60 head/ hour kill capacity	75 head/ hour kill capacity	90 head/ hour kill capacity	110 head/ hour kill capacity
Total Annual Kill	112500	140625	168750	206250
Total Investment/ head killed	55.37	53.51	54.49	54.08
Total Cost/ head killed	40.72	39.2	38.22	37.25

VII.4.1.1 Initial (Unconstrained) Solution

Highlights of the changes resulting from removing capacity constraints are as follows:

- Eliminates all interprovincial movements except:
  - West Ontario to Quebec
  - Prince Edward Island to New Brunswick
- Slaughter is down sharply in Central Ontario, but is up in Quebec because live cattle imported for slaughter go to Quebec instead of Ontario.

- Carcass movement from South Alberta to Quebec stops. Saskatchewan and North Alberta become suppliers to the Atlantic provinces and Quebec. Central Ontario no longer supplies Quebec.

- Boxing activity increases in North Alberta but decreases in Central Ontario.

- Some boxed beef moves from Alberta to Central Ontario.

- Cutting to consumer-ready increases in South Alberta and disappears altogether in Central Ontario. South Alberta becomes a major supplier of HRI cuts in Ontario.

- Exports of non-fed cattle come from South Saskatchewan and Manitoba instead of North Saskatchewan and North Ontario. Non-fed slaughter increases in North Alberta, North Saskatchewan, North Ontario, Quebec, and Prince Edward Island.

- North Alberta replaces South Alberta as the supplier of boneless beef to British Columbia. Boneless beef imports to Central Ontario and East Quebec increase.

VII.4.1.2 Solution With Economies of Scale Implemented

Highlights of changes evident after economies of scale were implemented (compared to the unconstrained solution) are as follows:

- South Saskatchewan slaughter goes down. Cattle are exported instead.

- Manitoba slaughter increases. Exports from Manitoba stop.

- Live cattle imports are slaughtered in Quebec and Central Ontario instead of North Ontario.

- North Ontario carcass beef is supplied from Alberta.

- Increased beef supply in Central Ontario replaces the boxed beef shipped from Alberta in the unconstrained solution.

- Non-fed cattle are exported from North Ontario instead of Manitoba. North Saskatchewan supplies North Ontario with boneless beef. Slaughter of non-fed cattle increases in Manitoba because economies of scale permit lower cost slaughter than in North Ontario.

TABLE VII.4.2: IMPACT OF ECONOMIES OF SCALE ON CATTLE SLAUGHTER ACTIVITY

Region	Estimated 1981 Capacity	Validation	Unconstrained	With Scale Economies
		(000 HEAD)		
B. C.	78.75	78.75	74.67	74.67
North Alberta	315.00	315.00	446.84	446.84
South Alberta	1177.50	1006.93	879.18	879.18
North Sask.	78.75	78.75	194.99	194.99
South Sask.	127.00	127.00	67.42	57.53
Manitoba	572.50	277.69	211.86	230.58
North Ontario	12.00	12.00	82.51	52.51
West Ontario	107.50	107.50	105.09	105.19
Central Ontario	1220.50	828.37	495.57	502.48
East Ontario	42.50	42.50	81.38	83.77
West Quebec	218.75	218.75	449.79	473.49
East Quebec	43.50	43.50	58.46	58.46
New Brunswick	37.50	37.50	19.75	19.75
Nova Scotia	11.25	11.25	11.81	11.81
P. E. I.	10.00	10.00	15.40	15.40
Newfoundland	.30	.18	.18	.18

It is apparent (see Table VII.4.2.) that even the small differences in cost attributable to economies of scale in cattle slaughter have an important bearing on the size and location of slaughter facilities in Canada. Implementation of economies of scale causes slaughter in Saskatchewan and North Ontario to fall back from the increased levels called for in the unconstrained solution. It causes increased slaughter (compared to the unconstrained solution) in Manitoba, Central Ontario, and West Quebec.

VII.4.2 PORK

Economies of scale in hog slaughter are reviewed in Table VII.4.3. Results of the experiment are presented in two parts: the initial unconstrained solution (with comparison to validation), and the final solution which is compared to both the initial and validation solutions.

TABLE VII.4.3: SUMMARY OF ECONOMIES OF SCALE ANALYSIS FOR HOG SLAUGHTER

ACTIVITY	Capacity (Head per Hour) 120	240	360	600
Total Annual Kill	225000	450000	675000	1125000
Total Investment/head	9.04	7.55	6.86	6.03
Total Cost/head	11.75	8.44	6.83	5.12

Highlights of the changes resulting from removing capacity constraints are as follows:

- There are no inter-regional movements of live hogs (except export movements).
- Slaughter declines in South Saskatchewan and Central Ontario.
- West Ontario slaughter increases and the region exports primals to the U.S. and Japanese markets replacing exports from Central Ontario and Quebec.
- Movement of consumer-ready cuts from Central to West and East Ontario ceases.
- Movement of processed product to North Ontario from Central Ontario is replaced by movement from West Ontario.

VII.4.2.2 Solution with Economies of Scale Implemented

Highlights of changes evident after economies of scale were implemented (compared to the unconstrained solution) are as follows:

- South Saskatchewan slaughter is reduced and some hogs move to North Saskatchewan for slaughter.
- Slaughter in North Ontario ceases and hog marketings are exported instead. Exports from West Ontario decline accordingly and slaughter increases.
- Slaughter in East Ontario ceases and hog marketings go to West Quebec for slaughter instead. Consumer ready and processed pork products move from East Quebec back to East Ontario to meet demand in that region.
- West Quebec replaces West Ontario and East Quebec as an exporter of pork primals.
- North Saskatchewan replaces Manitoba as a supplier of processed pork to B.C.

The impacts of economies of scale on the size and location of slaughter facilities is even more pronounced in the hog sector than in the beef sector. Hog slaughter in North and East Ontario ceases completely with marketings going to West Ontario and West Quebec respectively for slaughter. An absence of adequate slaughter facilities in Western Ontario for both the beef and hog sectors is indicated by both this and other experiments. This suggests that more attention to Western Ontario as a site for slaughter facilities may be warranted. A comparison of slaughter activity is presented in Table VII.4.4.

TABLE VII.4.4: IMPACT OF ECONOMIES OF SCALE ON HOG SLAUGHTER ACTIVITY

Region	Estimated 1981 Capacity	Validation	Unconstrained	With Scale Economies
		(000 HEAD)		
B. C.	431.0	339.0	339.0	339.0
North Alberta	1400.0	1042.3	1030.0	1030.0
South Alberta	650.0	571.4	571.4	571.4
North Sask.	390.0	390.0	522.8	556.2
South Sask.	265.0	265.0	144.6	111.2
Manitoba	1475.0	1219.6	1219.6	1219.6
North Ontario	0.0	0.0	11.7	0.0
West Ontario	5.0	5.0	1495.9	1507.5
Central Ontario	4040.0	3805.1	2302.5	2302.5
East Ontario	0.0	0.0	160.5	0.0
West Quebec	4160.0	3647.1	3126.4	3286.9
East Quebec	1270.0	1270.0	1611.2	1611.2
New Brunswick	137.5	137.5	105.9	105.9
Nova Scotia	178.8	178.8	212.3	212.3
P. E. I.	145.0	145.0	161.4	161.4
Newfoundland	30.0	30.0	30.8	30.8

VII.5 REDUCED SLAUGHTER CAPACITY IN PRINCE EDWARD ISLAND

VII.5.1 BEEF

This experiment is designed to analyse the effect of the announced closing of Prince Edward Island's only major slaughter facility on the beef slaughter, fabrication, and distribution system. All parameters of the system are identical to those in the validation except that the constraint on slaughter in PEI is reduced from ten to one thousand head per year to simulate the loss of capacity at the closing of the plant.

Highlights of the results are as follows:

- PEI fed and non-fed cattle move to New Brunswick for slaughter.
- Movement of fed cattle from East Quebec to New Brunswick stops. The extra fed cattle slaughter in East Quebec which results displaces non-fed slaughter.
- Non-fed cattle move from East Quebec to West Quebec displacing slaughter of fed cattle from West Ontario. The West Ontario fed cattle are slaughtered in Central Ontario instead.
- Carcass beef from Central Ontario meets carcass shortfall in West Quebec.
- Carcass beef supply for PEI comes from South Saskatchewan.
- There is no effect whatsoever on boxing activity or the movement of boxed beef.
- Boneless beef imports shift from West Quebec to East Quebec to meet demand in that region. Increased non-fed slaughter in West Quebec replaces imports in that region.

This experiment had very little impact on slaughter capacity utilization or shadow prices in any of the regions. Shadow prices in New Brunswick and PEI increased slightly and capacity utilization in Central Ontario also increased slightly (from 68 to 69%).

VII.5.2 PORK

This experiment is designed to analyse the effect of the announced closing of the plant in Prince Edward Island on the pork slaughter, fabrication, processing and distribution system. All parameters of the

system are identical to those in the validation except that the constraint on slaughter in PEI is reduced from 145 thousand head per year to 15 thousand head per year to simulate the loss of capacity at the closing of the plant.

Highlights of the results are as follows:

- Live hogs move from PEI to West Quebec for slaughter. There are no other adjustments in live hog movements.
- West Quebec captures some additional export market for primals at the expense of Central Ontario
- Demand for fresh cuts and processed products in PEI is met from East Quebec.
- East Quebec replaces P. E. I. as a supplier of fresh cuts to Newfoundland.
- Processing activity decreases in East Quebec and P.E.I. but increases in West Quebec and Central Ontario.
- West Quebec replaces East Quebec and PEI as supplier of processed pork products to Newfoundland.
- Central Ontario captures some export market for processed products at the expense of Western Ontario.

This experiment had very little impact on slaughter capacity utilization or shadow prices in any of the regions. Shadow prices in PEI and Newfoundland increased slightly. Capacity utilization in West Quebec also increased slightly (from 88 to 91%).

This solution causes some practical difficulties. Shipment of live hogs from P.E.I. to West Quebec is not an excessive distance in terms of road mileage but ferry transportation involving several hours may cause shipping problems (shrinkage and/or mortality) due to the length of time the animals are confined in a truck. Additional transportation costs for long distance transfers out of P.E.I. may be warranted to achieve more

realistic live hog movements.

VII.6 INCREASED SLAUGHTER CAPACITY

VII.6.1 BEEF

This experiment is designed to analyze the effect of additional slaughter in the East Quebec region. East Quebec was chosen because it had the highest shadow value on the slaughter constraint in the validation solution. All parameters of marketing, slaughter, fabrication and distribution are the same as those in the validation except that the constraint on slaughter in East Quebec is increased from 43.5 thousand head to 120.0 thousand head maximum slaughter. This represents a consolidation of some current capacity and expansion to a plant operating at 60 head per hour (the smallest in the financial modelling study).

Highlights of the results are as follows:

- Fed cattle move from East Ontario to East Quebec rather than to West Quebec.
- West Ontario fed cattle replace East Ontario marketings in West Quebec slaughter.
- Fed cattle do not move from East Quebec to New Brunswick as they do in the validation.
- Slaughter in Ontario decreases because more West Ontario cattle go to Quebec for slaughter.
- Several carcass beef movements change:

- Manitoba supplies N.B., replacing live cattle from E. Quebec
- Saskatchewan replaces Manitoba as the North Ontario supplier and Alberta as the East Ontario supplier.
- Alberta replaces Saskatchewan as the Newfoundland supplier.
- Ontario supplies less to Quebec.

- There are only minor adjustments in non-fed/boneless activities.

Minor changes in capacity utilization and shadow prices in Eastern Canada are shown in Table VII.6.1.

TABLE VII.6.1: NEW PLANT IMPACT ON CAPACITY UTILIZATION AND SHADOW PRICES FOR CATTLE SLAUGHTER

Region	- Capacity Utilization - Validation %	Increased Capacity-Quebec %	----- Shadow Price ------ Validation $/head	Increased Capacity-Quebec $/head
North Ontario			8.97	8.97
West Ontario			5.33	5.33
Central Ontario	68	63		
East Ontario			14.39	14.20
West Quebec			8.75	8.75
East Quebec			19.33	5.73
New Brunswick		69	7.63	
Nova Scotia			18.31	10.68
P. E. I.			16.23	8.60
Newfoundland	59	59		

Capacity utilization in Central Ontario falls slightly. Excess capacity appears in New Brunswick with only 69% utilization. The addition capacity in Quebec is not enough to create excess capacity in that

region and a small shadow value remains. It is interesting that consequences of increased capacity in East Quebec are borne by the industry in New Brunswick and to a lesser extent, Ontario.

VII.6.2 PORK

This experiment is designed to analyse the effect of additional slaughter capacity in Nova Scotia. Nova Scotia was chosen because it had the highest shadow value on the slaughter constraint in the validation solution. All parameters of livestock marketings, slaughter, fabrication, processing, and distribution are the same as those in the validation except that the constraint on slaughter in Nova Scotia is increased from 179 thousand to 300 thousand head per year. This represents a consolidation of some current capacity and expansion to a plant operating at 120 head per hour (the smallest in the economic engineering study).

Highlights of the results are as follows:

- There is no effect on any aspect of the industry west of Quebec.
- Nova Scotia to New Brunswick movement of live hogs ceases. New Brunswick slaughter falls only marginally in spite of this because some hogs move from East Quebec to New Brunswick for slaughter.
- Demand for processed pork products in Nova Scotia is still supplied from East Quebec but to a lesser extent.
- Movement of processed pork products from East Quebec to New Brunswick increases.
- West Quebec replaces Central Ontario as supplier of processed product to East Ontario.

The additional capacity in Nova Scotia reduces shadow values on slaughter capacity throughout the Atlantic region as shown in Table VII.6.2. The additional capacity is not very well used with a utilization rate of only 71%. The level of slaughter in Nova Scotia will support one small scale plant (120 head/hour). The consequences for other provinces are, however, minimal. Excess capacity increases only marginally in Quebec (88 to 87%) and in New Brunswick (100 to 92%).

TABLE VII.6.2: NEW PLANT IMPACT ON CAPACITY UTILIZATION AND SHADOW PRICES FOR HOG SLAUGHTER

Region	- Capacity Utilization - Validation %	Increased Capacity %	------ Shadow Price ------ Validation $/head	Increased Capacity $/head
West Quebec	88	87		
East Quebec			3.43	2.89
New Brunswick		92	12.50	
Nova Scotia		71	16.22	
P. E. I.			13.61	1.24
Newfoundland			26.63	12.85

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POOR

QUALITY

ORIGINAL